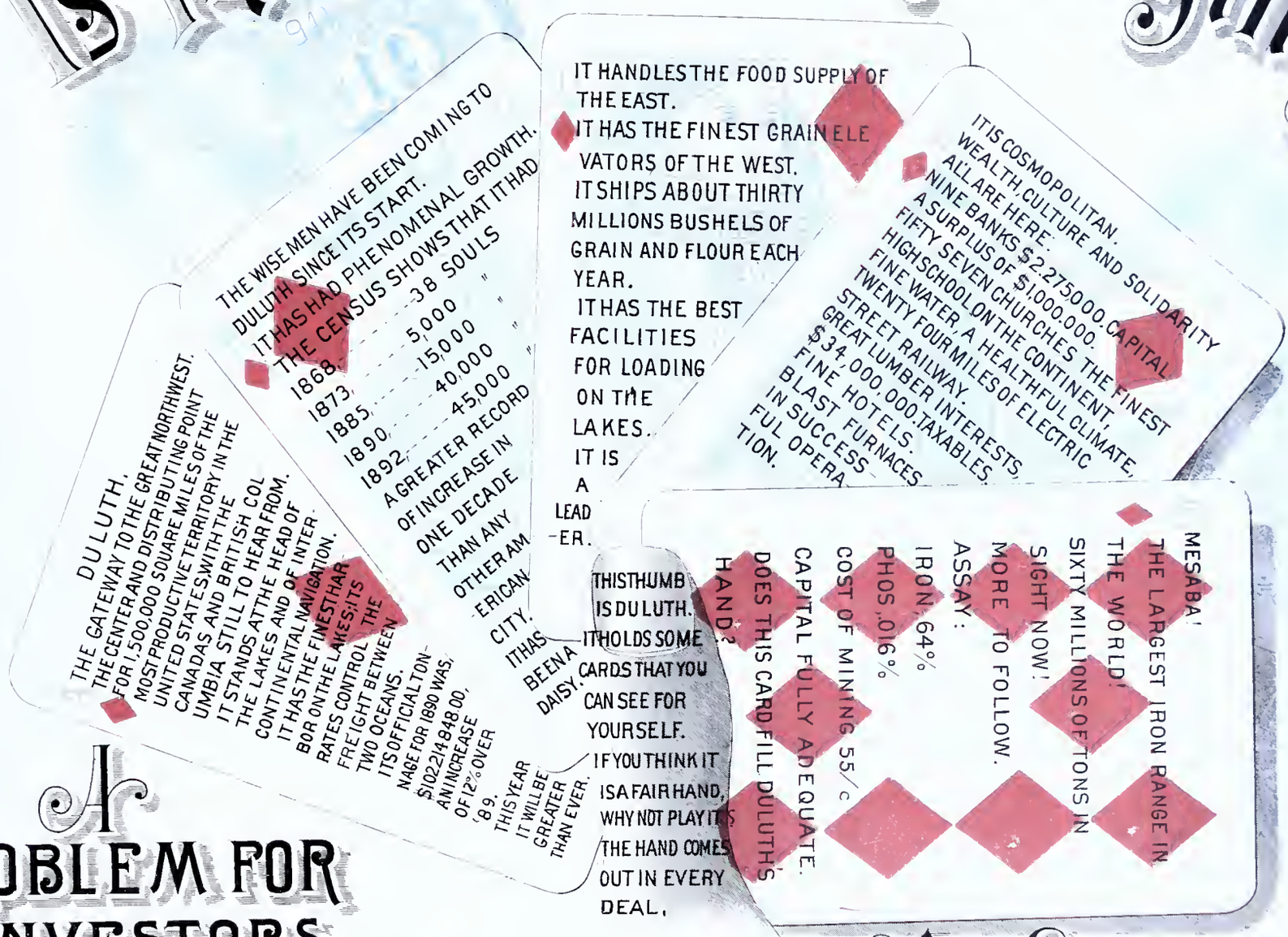
# Is this Hand Worth Playing?

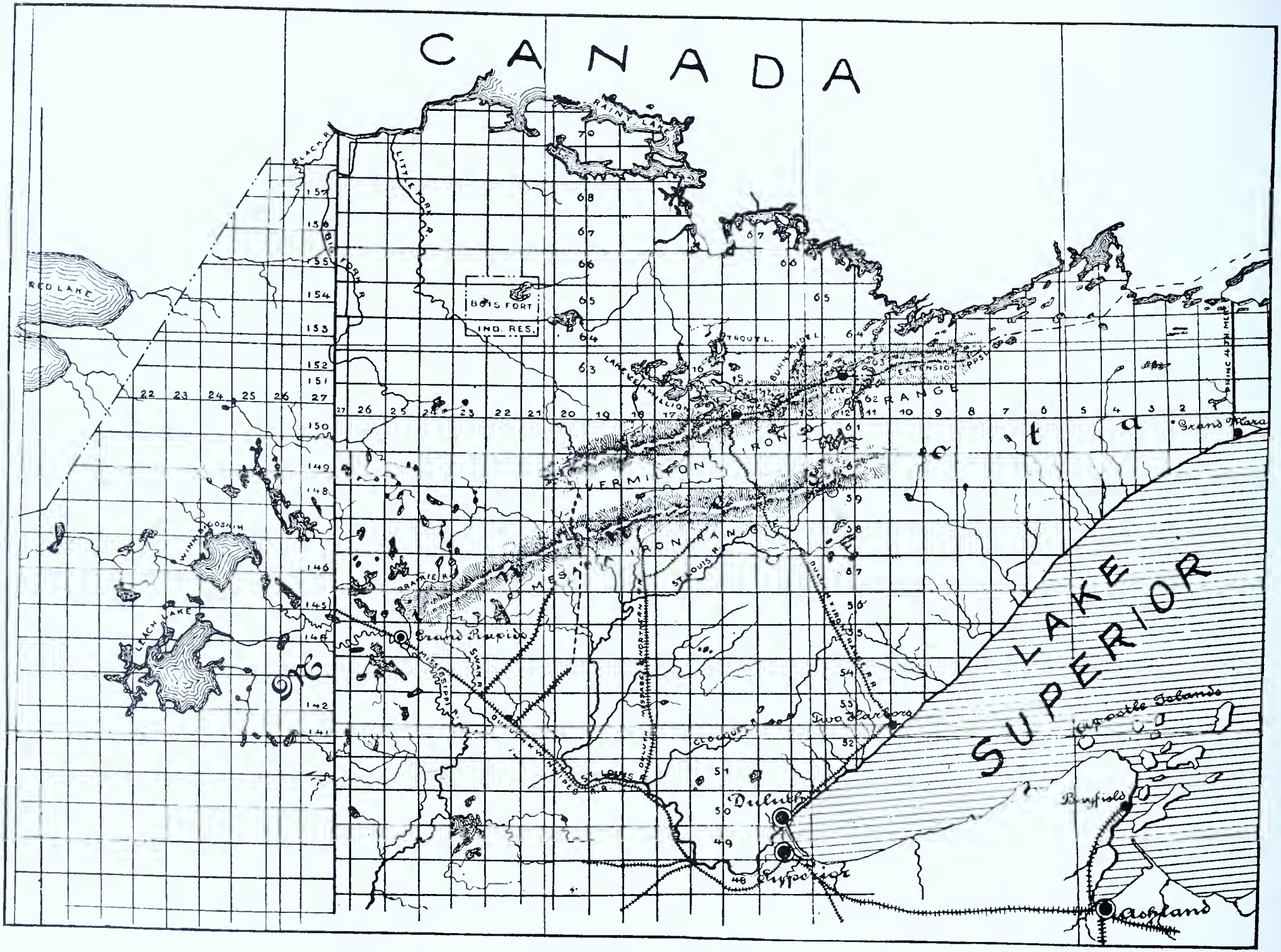



## A Problem for Investors

BY

## Marion Stuart Cann.

## The Great Mesaba Range.




MAP SHOWING LOCATION OF MASABA RANGE.

# Is This Hand Worth Playing?

A PROBLEM FOR INVESTORS.

BY

MARION STUART CANN.

# The Masaba Range

CONSIDERED SUCCINCTLY BOTH ECONOMICALLY
AND GEOLOGICALLY,

BY

MARION STUART CANN.

PUBLISHED BY
DULUTH STOCK EXCHANGE.
1892.

PRESS OF LeTOURNEAU & LEWIS,
DULUTH.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# PREFACE.

The preparation and presentation of this resume of some of the most important facts in connection with the more recent discoveries on the Masaba range, and their intimate connection with Duluth's increasing prosperity, is the outgrowth of the many inquiries that have come from those totally unfamiliar with the region until the recent exploitations brought it into such peculiar prominence.

To the end of facilitating the rapid dissemination of a knowledge of the region's richness, the Duluth Stock Exchange appropriated a sum sufficient for the purpose, and directed the writer to collate in a succinct and condensed form such data as were pertinent, making all deductions therefrom with candor and conservatism. An effort has been made to carry out these instructions to the letter, so far as the treatment of the various properties are concerned, and to avoid discrimination or invidious comparison. There is much that might be written of special localities along so extended an iron belt; but the design has been rather to give a macroscopic view of the region than to specialize. The matter brought together has been in many instances gleaned from reports and technical volumes not accessible to the general public, and often so interwoven with other things as to make it thoroughly impracticable for a business man to look it up. Other data have been secured by personal inspection. In no case has anything been used that has not been verified, or is from a standard authority. While the work is not, for many reasons, as complete in several respects as the writer could wish, it will be found to cover in a general way the location of the mines, the history of their discovery, the general geology of the region, and its correspondencies in other states, the relative value of the ore as compared with that or other states, the cost of mining similarly considered, the probable points of consumption, the cost of freight and the transportational facilities. From these groupings a comprehensive idea of the importance of the new discoveries can be fairly formed, and if such be the case, the labor will not have been in vain.

In the course of the preparation of the work the writer desires to acknowedge courtesy and co-operation that he received from many interested, and especially is he under obligation to Professors N. H. and H. V. Winchell, the State and Assistant State Geolo-

gists, and to Mr. Adam Bede, editor of *The Duluth Data*, and to Mr. George J. Atkins. Others who have given their assistance are Col. J. B. Geggie, Mr. W. B. Wells, S. A. Thompson, Secretary of the Chamber of Commerce, Maj. T. B. Hoover, Capt. Alexander McDougall, Mr. Leonidas Merritt, Judge J. T. Hale, Mr. R. S. Munger, Maj. Frank I. Tedford, Mr. A. E. Humphreys, Mr. A. J. Trimble, Capt. D. T. Adams, Mr. James H. James, Capt. E. Florida, Capt. T. A. Chadwick, Mr. H. B. Crowl, Mr. A. F. Bates, Mr. H. P. Barbour, Capt. Frank Hibbing, and the staffs of the Tribune, News, and Herald, and a number of others whose names have escaped the writer, because of brief acquaintance; but whose courtesies are thoroughly appreciated.

DULUTH, July 15. 1892. MARION STUART CANN.

# Is This Hand Worth Playing?

A PROBLEM FOR INVESTORS

BY

MARION STUART CANN.

# Anent Duluth's Hand.

THE reader who picks up this pamphlet to while away a few idle minutes may feel appalled when he learns that he is to be subjected to some statistics. It may be frankly confessed that figures are, as a rule, tedious and uninteresting. They are the last thing which a business man desires to see, except when they suggest to him commercial and investing possibilities worthy of effort for a handsome dividend. Then they possess a peculiar and lively interest. If they point out a path on which the anemone of prosperity blossoms all the way, and may be picked at will by the tourist, it matters little. If they make the route more picturesque than any other, so much the better. If they present an endless variety, and lure one from the common trends of commercial thought, so much more readily are they absorbed. These little facts and figures about the great Mesaba Range, and the intimate connection which it has with Duluth's industrial possibilities, exhibit all of these characteristics, and present attractions to every one on matters fiscal and commercial bent. To use an analogy, if you are a sportsman there is a pretty bag to be made among the wild birds who learn by instinct where the food is richest and most easily to be found. If you are a mountain climber, you will find that here the Pelion of Experience has been piled on the Ossa of Capital sufficiently to make it worthy of the best offices of your best tried commercial Alpin-stock; if you are nervy and want to test your mettle to the utmost, you can encounter both bulls and bears in the Mining Exchange, excited enough by reason of the daily developments to fulfill all the requirements of the most sanguinary; but you will discover after it all that the variety of the entertainment thus afforded all springs from the same source—the desire of the average American to make an honest dollar when he can, and his everlasting ability to see a first-class opportunity. Some of these things ought to put a new zest into your life. If they do not—if you are cold and curious as to how the Mesaba Range, the existence of Duluth, and the other factors cited are of any consequence to you from an investment point, join me in a little game which most Americans use to while away the time, and let us read our lessons and take our statistics through channels which have been authorized by Hoyle and dignified by the best statesmen that our magnificent country has yet produced.

If, gentle reader, you object to cards on general and well-grounded principles, this is the time to lay down this book. Without stopping to discuss the ethics of card playing, the writer is going to use the often fortunate, sometimes disastrous game of "Poker" as a crude illustration of the commercial position which Duluth now occupies.

It is taken for granted that you know the rules of the game, and consequently the value of the cards that any player may happen to hold. It is also held that in the general deal for commercial supremacy and industrial growth, Nature and Fate have stood together, pulled their guns and said that there should be a fair deal, and that the cards should come as they ran in the deck.

The man who stops to wrestle with caustry, and tries to explain how he happened to hold the hand that he does, retards the game—perhaps one like this, where the stakes are large. I am not going to do it. The facts can be gleaned in a glance by the "showdown" about to be made. I claim that it is a winning hand. A Royal Flush will never be beaten, and is bound to take the pot of commercial supremacy. The hand would have been very bad, but for a ten spot. One can see that at a glance. Nevertheless it is a game open and above board. Now let us see what the cards say.

## The Story from the Ace.

The first card which ran from the deck in the great natural deal was the Ace of Diamonds—certainly a good beginning for almost any hand that one may chance to get. On this you can consider that there appears printed the word Duluth, and a legend that tells that it is the natural gate-way to the great Northwest, the head of the navigation of the Lake Region, and the central distributing point of 1,500,000 square miles of the most productive territory in the United States alone, and must also be an artery for the output of the Canadas and British Columbia, whose tonnage is increasing each year. Its strategic position, the fact that it has the finest natural harbor on the chain of great lakes, that ocean-going vessels are able to come thousands of miles inland, and discharge and receive cargoes of every description with the utmost cheapness and facility, and that from every ramification of this great water-way, fleets of smaller craft are constantly collecting all the varied products of the contiguous region for the whale-back steamers which can girdle the globe, are interesting ones. Its rates control the freightage between two oceans. Its official tonnage for the year 1890 showed a value of some $102,214,848.00, and has been increasing at an enormous rate since that time. This year the season opens with a greater traffic in sight than at any previous time. The usual increment has been about twelve per cent. Is not this a pretty nice card to begin with?

## A Play from the King.

The next thing that comes out is the King, still in the suit of Diamonds. The story that he has to tell is chiefly of the wise men who have been coming to Duluth since it started, and who have seen it through all its vicisitudes, continue to write a history of phenomenal growth and development in bold and conspicuous letters, making a series of jumps in three decades unsurpassed by any other city on the continent. The census records show that in 1868 there were but 38 souls here, not enough to make a hamlet. In 1873 these had increased to 5,000. The year 1885 found 10,000 more had come rolling in, and made the figure 15,000. The great interests that had begun to center here, the vast amount of capital which had become to be accumulated, grew a more potent magnet to draw pushing, energetic young blood from the East and South. Middle and Central states saw their boys go flocking into

its busy streets, and in 1890 there were 40,000 persons to claim it as their home. Two years more roll around and again the figures are astounding; 5,000 more souls have been added, and it has trippled itself since it began to make its first gigantic strides. It has greater records of growth and solid prosperity than any other city in the world, and is still keeping up its phenomenal gait. This is the little story that the King can tell, and it safe to remark, "It is a Daisy," as one looks at the card already in the hand.

## What the Queen Narrates.

Prosperity always brings diamonds, and therefore it is not surprising that the next card which comes into Duluth's hand is of the same suit. It is the Queen of Diamonds this time, and she can well afford to smile serenely as she delivers her little message. Duluth, she tells us, is now handling the food supply of the East; and through her magnificent elevators, conceded to be the finest in the West, must go all the golden grain that comes from the limitless, billowy uplands of the Dakotas. Some are converted into snowy flour in her mills; some have already been stopped in transit and ground at some of the other cities which dot the great main arteries leading to the fertile Northwest; but all pay her a just and lawful tribute as they make their way to the seaboard, and the great consuming centers of two continents. Last year, says this interesting Queen before us, Duluth shipped Thirty Million bushels of grain and flour alone; beside doing an enormos traffic in iron, lumber, coal, and the miscellaneous freights that are constantly moving between coast and coast. Thousands of vessels blown by favorable winds, or propelled by that giant servitor, steam, have flitted about to handle this enormous mass of material for the promotion of civilization. They represent an invested capital of close on to a hundred million of dollars. Many of them are of the peculiar composite type, and have extraordinary carrying capacity. They are increasing year by year in tonnage and cost, and several of the finest which grace this magnificent merchant marine have cost as high as $350,000. The books of the Duluth Custom House show the registration of nearly every vessel known to the Inland Lloyds, and each year finds the number increasing. That lake commerce has not yet reached its great commercial importance, that from the happy wedlock of lake and ocean there is yet to be born many more and still lustier maritime offspring, goes without saying. This Queen, then, adds another nice card to the hand.

## Now the Jack Speaks.

The sequence which has thus far been running has been gratifying in the extreme, and each card which has come off the pack and gone into Duluth's hand has been one of extreme value. It is not to be wondered that the fourth one in the deal is watched for with interest. What? Diamonds again? Surely enough it is, and this time it is a Jack which comes out. Ace, King, Queen, Jack. Ha! That is encouraging. What does this Jack mean?

Singularly enough he is telling the story of cosmopolitanism; simply recording the facts of wealth, culture, solidary moral healthfulness, and all those things which go to make up the essential elements of a successful city. He tells of nine banks which have an aggregated capital of $2,275,000, and a surplus of over $1,000,000 —of a well organized Clearing House which disposes of business with promptness and accuracy—of 57 churches, which represent almost every denomination, and are all well attended—of a large and flourishing common school system clustering about a High School which meets the best requirements of a modern education, will be the finest municipal school edifice on the continent, when it is completed this year. The Jack also tells of the twenty-four miles of electric street railway, which belts the various portions of the city together—of the great lumber industry, of the spendid water supply, of the jobbing trade, of the blast furnaces which are in successful operation and are making a high grade of Bessemer iron at rates comparable with those of plants anywhere in the country. The Jack also calls attention to the fact that there are fine hotels, theaters, libraries, museums, one of the finest Masonic Temples in the Northwest—in short, a healthful, happy, well-governed city of prosperity and of homes, where all those things which tend to the best achievement of life have been thought of and provided for; and men are co-operating on every side to bring about the highest and best civilization. This card of the Jack has been a wonderful factor in Duluth's past history, and he means even more for it in the very near future.

## The Last Card Out.

Four cards have now been dealt to Duluth. I think that the average reader will agree with me that they have all been excellent ones; and that might any city in considering itself entitled to prestige that can show anything like them. But there are fifty-two cards in the pack, and a great many good hands. The combinations which they have formed as Old Nature has hurried them across the baise of the last century, have made some wonderful strong hands, and they have been winning ones in many instances in the great game of commercial supremacy. Birmingham, Alabama, went in with Threes—coal, iron and limestone, all contiguous, and won a fair share of the stake. Other cities have had two pairs, or a bobtail, or some others of the possible hands which might have been expected, and made other players lay down when there was no real necessity for it. Such things were always possible when every man is backing his own judgment and doing a small amount of bluffing to keep his courage. There is only one stage of the game where there is an absolute certainty, and where the holder of a single hand can know positively that he can not be beat.

Up to last summer Duluth had a fine hand, the way the hands have been running, but it was not until the last card was thrown to it, that it knew that NOTHING could beat it.

# The Masaba Range.

A RESUME OF THE SPECIAL ADVANTAGES OF

# This New and Wonderful Mining Region.


BY

MARION STUART CANN.

# By Way of Introduction.

EVER since the time when the late Jay Cooke drew his wonderful system of concentric circles with the point where Duluth now stands as a center, and uttered his inspired prophecies as to her future, the city which, in a storm of the most humorous exaggeration that could fall from his eloquent tongue, was immortalized by the Hon. Proctor Knott, of Kentucky, has been immortalizing itself by prodigeous strides, and by the astounding revelations of the ceaslessly developing richness with which kind Nature has endowed it. It was, indeed, born to good luck, and when circumstances have conspired to retard its progress, whenever hard times, and deep depressions over extended areas have impelled a curtailment of its indomitable enterprise, something new has unexpectedly happened to give a fresh impetus to its vigorous growth. The phrase "unexpectedly happened," however, must here be taken in a very restricted and qualified sense, that of the trite and commonplace proverb, which like all of the class to which it belongs, expresses that which exactly is not true. It is the unexpected that never happens; one only reads from causes to results; and it was a non-appreciation of this fact which made the world in general, and Mr. Knott in particular, thouroughly incredulous of Jay Cooke's prophecies, and which have, in most instances been fulfilled since that time. There is no caustry about it. All things mundane as well as all things spiritual, act in conformity to fixed and eternal laws that have been laid down by the Great Architect; and the student of history, the scientist in any of the great divisions of clasified knowledge; the business man—yes even the little child, learns and sees this with each day's experience. The locations of cities, and their prosperity and progress are neither accidental, nor are they determined by man's design. The mighty forces which have been shaping the destiny of the human race since it first awoke in its Asiatic cradle, and have impelled through thousands of years, such shifting and readjustment of nations and centers of population as were necessary for the advancement of civilization and the elevation of the race, determine where cities shall be built; and the more thorough our understanding of these forces, and the modes, by which they act, and the more conformable our plans to them, the more enduring the local triumphs of progress and prosperity.

The application of these great laws, or some of them at least, is being better understood each year. The primary principles of the laws of supply and demand, of interchange of commodities, of available locality as applied to manufacturing, and a number of others enter into the calculations of most intelligent business men, and are the barriers between them and mistake. They desire specific information from reliable sources; and then they feel confident to make their own generalizations. Such is the general object of this pamphlet, which has been compiled only from the most reliable sources available; and has been secured from specialists who are standard authorities in their particular lines, throughout the whole country.

The great interest which has been awakened in the Masaba Iron Range in last few months, and the desire that there seems to be on all quarters to get more detailed information about it, has prompted the Mining Exchange of Duluth to have a statement as full, as frank and as accurate as may be, and yet devoid of any high coloring or exaggeration. If, in the microscopic view of the situation herewith given are found extraordinary, and seemingly incredible conditions, as undoubtedly there will be, there are numerous ways for the reader to verify them; and the closest investigation is courted; for it is to the mutual advantage of those who are interested in this rich field, and those to whom these presents will come for the purpose of interesting them to the point of business investment in the great work of development that is going on, that the examination of the wonderfully favorable conditions at Duluth and on the Masaba range be thorough and complete.

The peculiarly advantageous location of Duluth, as regards inter-continental traffic has been demonstrated year after year, since 1869, when the place took its first step forward. After attention was first attracted to our young city, by the prominence that it gained in the congressional halls, bit by bit, the mental surveys of those looked into the matter extended from lake to lake and from ocean to ocean. As a focal point at which must eventually converge the principal rail and water ways of the continent, the practical advantages of the place as a commercial and distributing center became more and more apparent, and even before the period which has come down as the "boom" had set in, it was recognized that this main gateway to the great Northwest was to attain a commercial supremacy that would make it the worthy rival of any city on the lakes, if not eventually, indeed, that of the seaboard metropolises which are now radial to it, and which effect their interdependent exchange of commodities through its common center. The breadstuffs and lumber of the Northwest, the many raw materials of the lake region, here must make clearance with the manufactured products of the busy East, as the whirl of trade on all sides of the continent exercises the centrifugal tendencies of mutual advantage to draw capital, enterprise and energy to this common center. All these facts are now conceded by intelligent business men everywhere. The march of development has gone on ceaselessly along the shores, across Minnesota Point, upon the hillsides, and along the bays until a myriad of lights glint out across the great inland sea to tell the tale of happiness, progress and prosperity.

All of these things had been foretold; and when one looks carefully to the general conditions on which these prophecies were based, there is nothing surprising about their fulfillment. It was not thought, however, until a few brief months ago, that still greater potentialities for the development of Duluth were yet to be discovered, and that through them, in addition to the commercial supremacy which other forces were irresistibly bringing about, that there was immident a new industry, and one that will be greater than all of the others combined. This conviction only came with the discovery and development of the rich iron deposits of the Mesaba Range, and a comprehension of the vast-

VIEW FROM LAKE VIEW TERRACE.

ness of this ore body, the extreme cheapness with which it can be mined, and the supurb transportational facilities that are available to it, will suggest the peculiar forces and conditions which are soon to bring about a readjustment of the great centers of iron and steel fabrication of the world and make it an active competitor in this most valuable and lucrative of industries. In the following chapters an effort will be made to give succinctly, and in a non-technical way the general features of the Masaba Range, and those things which must be natural concomitants of such conditions as have been demonstrated to exist beyond peradventure.

ON THE EMBARRASS.

# In a Manner Historical.

THE neglect for so long a period of the Masaba mines and the mineral richness of the entire range was purely fortuitous and in some respects was unique. It was away back in the "sixties" that a rumor of gold in the hills on the northwest shore of Lake Superior began to be bruited about. It came originally from the Chippewa Indians, some of whom asserted that there lay about the shores of Vermilion Lake enormous deposits of the precious metal, which, they said was the treasure of the great giant MESABI, who according to the legend of the Grand Marais Indians, lay entombed in the Giant's range, the various members of his body being represented by the spurs and subordinate ridges. The region where the gold was alleged to be would correspond well to the proper location of the wampum belt on this deified hero had he possessed the colossal proportions that the topography of his apochraphal grave would indicate. The aborigines held the "hights of land" in much awe, and the folk-lore indications are that their "Mesabi" corresponded in a crude way to the Atlas of Greece, and the other world supporters of the Aryan-descended nations.

The repeated asseverations of the Indians as to the gold deposit had their effect on men who cared neither for the legendary giant, or his corelation with the myths of other ages and climes. They wanted his gold, if he had any, and they were willing to go after it. The more the thing was talked of, the greater grew the excitement, until, in the winter of sixty-two, a party started for the shores of Vermilion lake in 61-16, where a new mining town was to be established. The trip was made with sleds and dogs, and after an adventurous journey, the town of Eviston was located. Among the party were as leading spirits, Messrs. George R. Stuntz, J. I. Post, and Hon. William Nettleton. Mr. Stuntz then marked out the road which is still used, and pushed on as far as Pike river.

Eviston grew apace. All through the winter the excitement over the alleged deposits and the fascinations of the great American game which whiled away the semi-Arctic nights kept spirits boyant. Of course there was no gold found, and at the end of a fitful season, the deserted town with its embryonic civilization was relegated to the primeval wilderness. Today its site is marked by dozens of shafts, wrought with labor, and fraught with bright hopes destined only to be blasted, that remain as monuments to the craze, and are located on what has been very appropriately named Sucker Point.

It was on his return from Eviston, that Mr. Stuntz discovered the outcrop of the ores on the Vermilion range, at what is now the Iron Mountain mine of the Minnesota Iron Company. He managed to interest Col. J. B. Culver and Mr. George C. Stone, and they located the place with Sioux script. At this time it was permissible to raise the script after a certain period of occupancy, and this was done. Subsequently Mr. Stone, who had firm faith in the deposit, relocated the land, and the wonderful developments of the Vermilion range were the result.

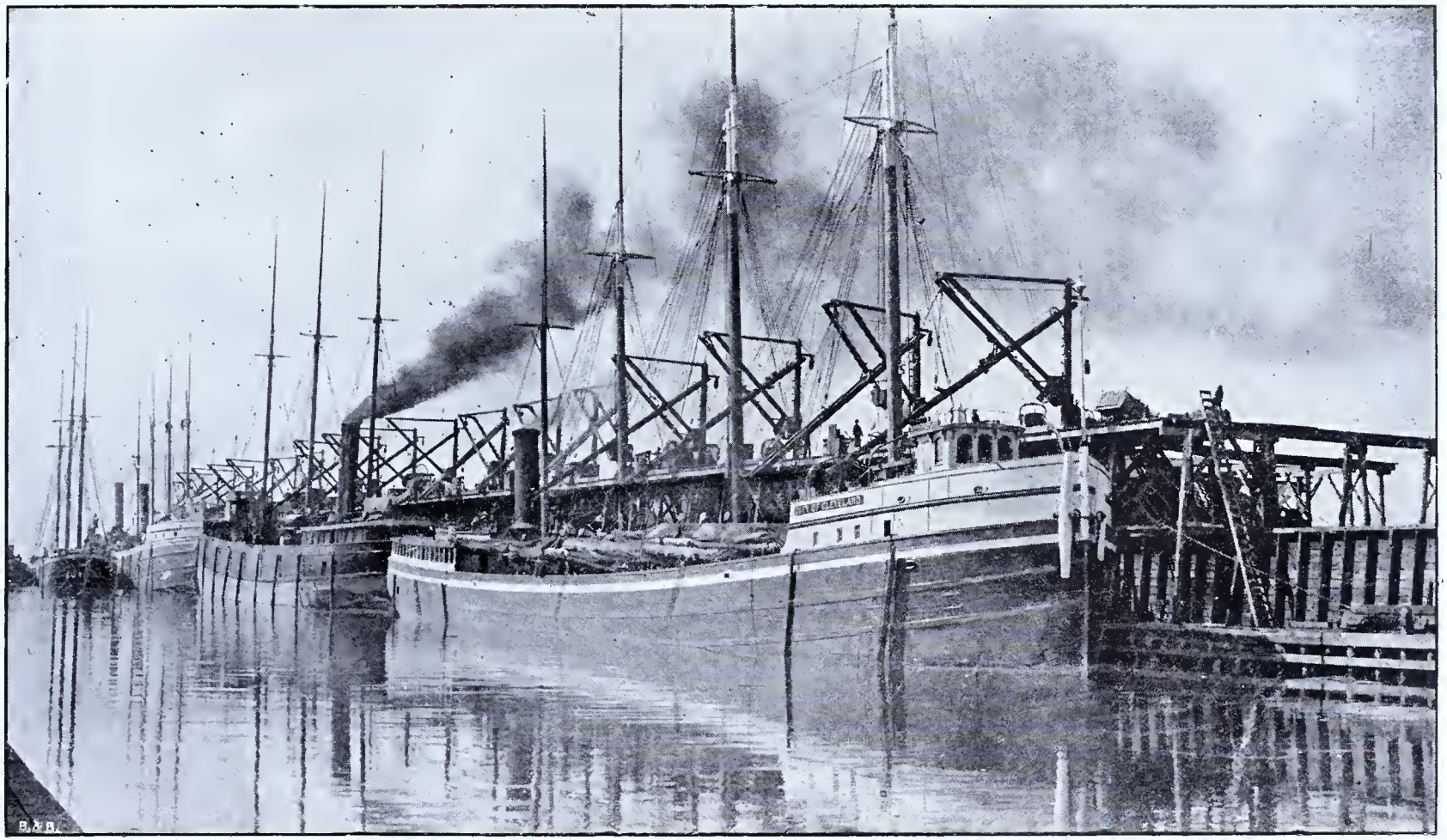
The existence of a large belt of iron ore this side of the Vemilion range had been known for years. Mr. Leonidas Merritt remembers that when he first came to Duluth, in 1856, he was told of it by E. F. Ely, a scientist, and a thoroughly practical man who had a broad comprehension of the immense wealth that the region contained. He foresaw that some day its development must be a most potent factor in the building up of a great manufacturing city at the head of the lakes, and was enthusiastic in his prophesies. But it was hard to awaken any great degree of enthusiasm among others in the discovery of an iron deposit that was on the frontier, almost, in a wild and desolate country, two hundred and fifty miles from the nearest railroad, in the midst of a wilderness, and surrounded by a seemingly interminable forest, with lakes and rivers intervening between it and the consuming centers. Later some effort was made to organize a company and thoroughly explore the Masaba; and the project was agitated off and on for several years; but this was two decades ago, and the time was not ripe. As the railroads came in, and the population began to center around what Mr. Merritt first saw only as a boat landing, the discovery of the Vermilion deposits drew all attention on them, and again the nearer range was neglected. It was not until last summer when the glance of John McCaskill was attracted by the appearance of iron ore adhering to the roots of an upturned tree, on Judge Hale's property, in section 1 of 58-16 that Duluth really awoke to the fact that there was at her doors THE most extended and uniform iron bed in the country. Since that time development has been pushed with great energy, and already three of the properties have been most advantageously leased to eastern iron masters and ore syndicates. There are some fifty or sixty companies organized, and mining camps dot the range for miles.

In 1888, Col. Geggie and others whom he had associated with him began operations on section 20, in 59-14, having had their attention directed to the mineral bearing character of the locality by the exposures of rock made in a cut on the Duluth & Iron Range road. They drove seven shafts and three test pits, which were untimbered, the greatest depth reached being 120 feet. Lymonite in paying quantities was found, and has been since successfully worked.

The Mountain Iron Company, now a successful organization, was one of the first to take a hand in the development of the range. The leading spirits on this exploitation were Hon. Leonidas Merritt, K. W. Chase, others of the Merritt family, and their associates. Work was begun in March, 1889, and its prosecution revealed the presence of a large amount of soft blue hematite which is now being successfully mined.

The Mallman mines were next to be developed in the eastern part of the range, and as will be seen in the analysis elsewhere given, have struck an excedingly fine body of ore. They are located east of the Duluth & Iron Range road, as is also the Myrna mine. It was put down in 1888.

Well up on the eastern extremity of the range, where the spurs of the Giants, Vermilion and Masaba unite, in 65-5, Messrs. Hoover and others have sunk a number of pits into the magnatite



COAL AND IRON DOCKS.

ore. These were begun about the same time and one pit has already reached a depth of twenty-seven feet, in black magnetic ore that runs from sixty-one to sixty-six per cent metallic iron, and is free from titanium.

Space will not permit the discussion of each mining property in chronological order of location and development, if, indeed, it were worth while to go so much into details. The following list represents most of the mining locations as laid down on the new map of Mr. D. T. Adams. Many of them have been incorporated as companies within the last year; others are still held as private lands:

Birmingham,
Comstock,
Pittsburgh,
Biwabic,
Dayton,
New York,
Youngstown,
Chicago,
McKaskill,
Elmira,
Republic,
Iron Cliff,
Lake Superior Iron Co.,
Cincinnati,
Great Western,
Oneota,
Smith & Gardner,
Behringer,
North Star,
Kakina,
Columbia,
Putnam,
Iron Belt,
Ballard,
Northern Light,
Pennsylvania,
Security Iron Co.,
Detroit,
Bessemer,
Masaba Monarch,
Athens,
Vermilion Pine & Iron Co.,
Washington,
Lackawanna,
Kentucky,
Mesaba Mountain,
Shaw,
Little Masaba,
Twin City,
Carnegie,
Charleston,
Canton,
Mallman,
Billings & Wing,
Humphreys,
Mesaba Chief,
Buckeye,
Lincoln,
Clarke,
Stowell,
Gridley & Hale, and Stryker, Manley & Buck,
Meyers & Plain,
Mountain Ash,
Swedish American,
Minneapolis,
Camden,
Bradley,
Ohio,
Missabi Iron Syn.,
McKinley I. Co.,
Kanawha,
New England,
Keystone,
Myrna,
Minn. Mag. C. C. Co.,
McKinley, Humphries, & Billings,
Rouchleau,
Champion,
East Canton,
Towanda,
Hale,
Newcastle,
C. C. Stone,
Aurora,
Humphreys, Judd & Wilson,
J. & W. McKinley,
McKinley & Charnley,
Nelson Dands,
H. B. Moore & Co.,
Rouchleau & Higgins,
Cosmopolitan.

# The Location of the Masaba Range.

IF THE reader will find the location of Duluth on the map, he will see that it lies at the southwestermost corner of Lake Superior, where Minnesota Point extends nearly to the Wisconsin shore, and forms a tranquil natural harbor that is surpassed by no other in the lake region, if by any other in the world. It is broad enough to accommodate the entire merchant marine of the world, and has so far improved as to be available in all portions for steamers of the deepest draft, and from which, with the contemplated improvements in the canal at Sault Ste. Marie, craft will be able to sail directly from it to any port on the globe. Following the line of the northwest shore from Duluth to the Pigeon River Indian Reservation will establish a line that runs approximately northeast and southwest. Back from the shore about fifty miles, there will be found laid down a chain of mountains known as the Vermilion range, which have already become justly celebrated for the high grade of Bessemer iron ores that have been taken from them at Tower and Ely, and which are said by Prof. Winchell, of the Minnesota Geological Survey to be surpassed in purity and richness by no other iron ores mined to any considerable extent in the world, not excepting the famed deposits of the Ural Mountains, which for years took precidence in the best mineralogical cabinets as the most representative specimens of absolutely normal ores.

Between this Vermilion range and the shore of the lake, there is another, and lower range of hills known as the Mesaba. It is not in fact, the true Masaba. That lies a little beyond it, and is composed chiefly of Lower Cambrian rocks, in which little or no mineral is found. The nearer hills of the Masaba on which the rich deposits have been found extend from the Canadian boundary line in Cooke county, Minnesota, to the Mississippi river in Itasca county, a distance of about one hundred and fifty miles, and have a general direction northeast and southwest, with considerable local variation. The general topography is much broken. The hills are fringed heavily with pine, and occasionally with hard woods; and the surface is rent, cleft and fissured, showing occasional uncomfortable strata, and other effects of the convulsions that there took place when the continent was aborning. This range constitutes some of the highest land within the confines of the State, and is an important water shed which defines three large drainage basins. From its eastern slopes the waters flow to the lake, and find their way to the Atlantic ocean by way of the St. Lawrence river; on the northern exposure the natural channels empty into Hudson's Bay, and thence to the Arctic ocean; southward and westward they find their way to the Mississippi river to mingle with the sunny waters of the Gulf. The altitude of these heights of land is about 1,710 feet above sea level, and over eleven hundred feet above the surface of Lake Superior. The name of the range signifies this fact. It was given it by the Chippewa Indians, and in their dialect signifies "A Great Height." The usually accepted spelling of the word, and oen

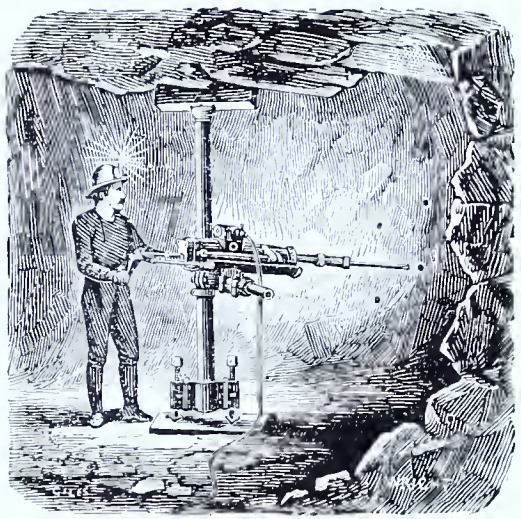
that has been used on most of the maps of the region is the one that has been adopted in this pamphlet; although there has been of late considerable controversy as to just what were the proper vocal and literal equivalents, and no less than seven different forms of it have been seen in type since the region came into such peculiar prominence. Some of the oldest inhabitants of the region, and men who are familiar with the dialect of the tribe who gave the name pronounce the last vowel with a soft *i* as that in the word Mississippi, which also comes from the same source.

The country all through these hills is rough and broken, and shows many evidences of glaciation and moraine deposites. Huge boulders loom up amidst the mast-like pines, ledges of granite, jaspilyte, green stone, and other igneous rocks frequently terminate in abrupt escarpments where they out-crop on the crest of the ridges, and, in the higher levels, the monotony of the forest is broken here and there by picturesque lakelets whose clear blue waters reflect the rugged wildness of this yet almost primeval fastness. It is near one of these lakes, the Embarrass, that some of the best properties have been developed during the past few months; and, beside the lake, there has sprung up with Aladdin-like celerity, the town of Merritt, which is already incorporated, has elected its municipal officers, and boasts of a good hotel, a newspaper, and the other appointments of a mining center. The Duluth & Iron Range railroad, which at present extends to Ely, on the Vermilion, is building a branch from Masaba station to Merritt, where it will unite with some of the other roads that are making for the heart of the region, and thus belting it, northeast and southwest, giving a score of companies ample transportation facilities. The contours about the lake are such that there is a gentle slope from the out-cropping greenstone which is the northern limit of the ore, toward the lake; and the roads will have easy gradients up to the working face of the mines.

These two ranges, the Masaba and Vermilion, together cover a larger territory than is embraced in the three great fields of Wisconsin and Michigan, known as the Gogebic, the Marquette and the Menominee, and exceed them by many thousand acres of productive property. The entire territory of the townships through which the ranges run, aggregate about 1,700,000 acres. The Masaba has the largest uninterrupted stretch of ore formation that has yet been discovered, and is not by any means fully explored. The 130 miles that has come under close study during the past year shows a wonderful uniformity and continuity, and in forty-one townships, observations point to a general persistancy of the beds. Of course the back bone of the ridge, which shows the line of the greenstone out-crop, which has been chiefly used in identifying the location of the most available portion of the ore body for cheap and immediate mining, crosses but a small portion of each one of the townships; but it is very generally conceded that at all points below the line of the out-crop, for several miles the ore will be found at a greater or less depth. The dip is very slight, being generally from twelve to twenty degrees to the southward, and, as will be seen by Prof. Winchell's opinion of the genetic origin of the ore hereinafter referred to,

SCENE ON SPIRIT LAKE.

the probabilities are that wherever the contour of the surface was such as to form a trough during the period of sedimentation and concentration, the deposit may be looked for with increased thickness toward the heel of the bed. For this reason it will be difficult at this time to estimate the actual content of the deposit, and the figures given hereafter do not attempt to do that. They only give a conservative estimate of the ore that is now in actual sight by means of the hundreds of test pits which have been put down, on a ratio of the average thickness that has been revealed by them. On some individual properties the development has proceeded so far that figures for a limited area might be made much more closely and increase the aggregate tonnage considerably; but it has been deemed judicious to keep on the safe side. Even then the figures are surprising enough.



# Geology of the Masaba Range.

THE rocks of the Masaba Range belong to one of the oldest geological formations which appear within the confines of the State of Minnesota. It has been classed by Geological Survey of the State as belonging to the Taconic age, and constitutes a terrane of formations which contain the primordial fauna—at least do the portions of them which are older than the Potsdam of New York State. It is practically the Lower Cambrian of the English geologists, and the Huronian of the Canadian Geological survey.

Much of the entire horizon comprises some of the highest land in the State, and its most important triple water-shed. The rocks of the Taconic consist chiefly of carbonaceous and argillaceous, but often very siliceous slates, and quartzites and gray limestones. The quartzites are generally fine grained; but in some places become coarse and even pebbly. The beds lie either horizontal or dip to the south at an angle of from three to twenty degrees. Intermingled eruptive rock material is found very generally among all the members of the group as fragmental, non-porus tuff, interstratified in the formation. There are abundant evidences that the rocks which constitute this group, with the exception of some periods of comparative tranquility, were deposited during a period of violent volcanic disturbance, together with oceanic transportation.

These facts are true of nearly the whole terrane, which includes four different ores, all of them distinct, and accompanied by such characteristic rock that they are easily identifyable, lithologically and stratigraphically. Of the actual distribution of some of them comparatively little is known, except where they have been opened up within the last few years; but wherever there has been practical exploitation on any of the properties, it has revealed deposits of great richness and abundance.

In Bulletin VI., Prof. N. H. Winchell says: "There are four methods of occurrence of the ores of the Taconic, as there are four distinct kinds of ore, viz:

(1.) The quartzose-hornblende magnetite group.
(2.) The impure jaspilitic-hematite group.
(3.) The carbonated iron group.
(4.) The gabbro-titanic-iron group.

The first is the most important as a probable source of large quantities of merchantable ore in the near future. The second is interesting because of its resemblance to the jaspilitic ores of the Keewatin. The third exemplifies the manner of occurrence of a large body of ores, the value of which, in Minnesota, would be enormous, if there could be discovered some metallurgical process for their economic reduction, and the fourth represents in Minnesota, what appears to be an important source of ore in the Penokee-Gogebic range."

The ores of the first group are found associated with the coarser parts of the Pewabic quartzite, and also interleaved with

the jaspilyte, and are found typically developed in the northeastern part of the Masaba range. The rocks which enclose the ore varies considerably at different points, shading away from a coarse quartzite in which the rounded granules are visible to the naked eye to a much more close textured rock in which green hornblende and olivine mingle. The report referred to describes the magnetite as at first appearing in the formation in the shape of isolated granules, which occasionally show the octahedral crystallization of the isometric system. As these increase in frequency, the quartzite gradually changes to iron ore, and the accompanying rock becomes heavy and dark colored. A development by the Stone Iron Company is cited in the report as probably referable to this group, since it seemed to the State Geologist, who at the time of writing had not had an opportunity to make a personal examination of the mine, as having all of the characteristics. Within the past few months, as will be noted farther on, large finds of this ore have been made in 65-5 and at other points on the upper end of the range, and promise even as great surprises as have been met with lower down where there is now so much activity.

The second group, that of the impure jaspilitic hematite and limonite ores has been met with as an outcrop on the rapids of Prairie River near the Mississippi River, and as yet has not been developed to any extent. The probabilities are that it will be found to give a definite and local character to the beds at the extreme western extremity of the range. It also commences with granules scattered through a jaspilyte formation, which shows the bands and waves of the mother rock. As these become more fully disseminated throughout the rock, it gradually changes to ore, but it is a hematite, more or less impure with silicious red specks and veins. There has been so little exploration in the horizons where this is supposed to exist, that its comparative value as a workable ore can hardly be estimated.

In speaking of the third group, the carbonated iron group, the report referred to foreshadowed what has come to pass in the past few months, when it said: "This, as a source of iron ore in Minnesota is potential rather than actual, and it is here ranked on an equal scale with the foregoing because of its apparent great importance on the south side of Lake Superior, especially in the Penokee-Gogebic range of Wisconsin and Michigan." Since this was written, the potentialities have become actualities in the shape of some sixty million tons of ore of high grade now in sight, and such a magnificent confirmation of theoretical prognosis must be gratifying indeed to the scientist who made it.

There is no adequate description of the ores that are now being developed on the Masaba range in this report from which the writer has been using excerpts so liberally from the fact that at the time it was written the central portion of the range had not been explored. Stratigraphically it is there placed as lying below the jaspilyte horizon and above the quartzose-hornblendic magnetite zone.

It is accompanied by a characteristic fragmental quartzite, which lies unconformably on a green stone, and forms the footwall of the ore, and rests upon the granite of the Archæan rocks

which form the Giants, which is north of the true Masaba range, while the hanging wall is a black slate. The tendency of this ore to undergo a secondary change is shown along the lines of the out-crop—if a deposit with three feet of drift upon it can be properly said to out-crop—by its readiness to assume the form of ferric oxide, and the rusty and ocherous character of those portions which have come in contact with the seepage from the surface.

In outward appearance the ore varies considerably, ranging from a yellowish ochreous on the upper part of the bed to a deep and characteristic grayish blue, and occasionally iron gray, with bands of reddish material. On some parts of the range, particularly near the center, and west of the Iron Range road, portions of the bed constitute a very fine paint rock, and some of it is being mined for that purpose. With proper menstra it gives a fine reddish brown color, and its density gives an excellent body to the paint for bridge, car and similar work, where a durable paint is required.

In several of the pits, at apparently the same position in the bed, several inches of ore with a bright metallic lustre have been found, and these are succeeded by a layer of very dark powdered ore that looked almost like black oxide of manganese. Immediately below them the ore was again the normal blue gray that is generally characteristic of the deposit. The streak is almost a cherry red, as is also the powder of the crystallized portion which has such a splendent lustre. Some limonite has been found on one or two properties, but the hydrated ore is unusual.

The Gabbro-Titanic iron group, which constitutes the fourth of the series of ores laid down by the Geological Survey, embraces by far the most abundant deposits of iron in the State, and the lithological characteristics are such that it is an ore easily identified. It does not manifest itself to any great extent on the center of the Masaba range, but is abundant throughout the region. It is an ore that runs high in that bane of furnacemen, titanium; and thus far there has been outlined no metallurgical process that will make it available as a productive ore. It is found in immense masses all through the horizon of the member of the terrane from which it takes its name; but the ores of this formation constitute one of the tablets on which nature has written the record of her capriciousness. At some period subsequent to the deposition and transformation of this ore from the original rock, one of the throes of the earth's original crust rent it with many a seam and gash, and through these there escaped a molten stream of eruptive rock varying from gneissic to granitic character, which impregnated much of the ore with which it came in contact with titanium. Some of it came into fields where there had been previously deposited the quartzite with other iron masses, and now, in the territory covered by this gabbro flow, there are promiscuously intermingled ores that are titanic and those that show no trace of this element.

Embracing as it did, large areas of magnetic ore, it was one of the first iron bodies to come under the observation of the Geological Survey on account of its wide distribution. Its name has not only created a prejudice against it among iron men, and one

that extends to any locality where the gabbro exists, but it has also led to a serious misconception of the reports which have referred to it, and a very unjust condemnation of the geologists who made them. The writer has heard expressions of a character indicating this, since he has been on the range. While it is quite true that the report which has been quoted does very properly assert that many of the ore deposits found where there is a gabbro formation are titanic, it qualifies the dictum with this sentence, which recognizes the existence of two distinct grades of ore within this horizon: "It will not be safe to infer that because a magnetic ore body is contained within the general area of the gabbro, it is therefore to be condemned as titanic, although that would be generally correct. It may be non-titanic, and derived from the Pewabic quartzite, or from some other part of the Animike, and it ought to be inspected carefully by one familiar with the distinctions between titanic and non-titanic ores, and as a final test should be examined chemically for titanium."

The rock which contains these deposits is an eruptive one, of a gray color, and generally of coarse crystalline structure, containing labradorite, rutile, augite, magnetite, biotite, etc., and all of the mineral constituents vary considerably in their proportions at different exposures. In some places so great is this variance that the rock itself takes on very perplexing aspects to those who are not familiar with the idiosyncrasies of the formation. The gabbro is often associated with the red syenites, the quartz porphyries and the various other sedimentary rocks which are members of the same group, although sometimes these are wanting. This titanic ore presents an interesting study, although it has just now no special commercial value. It is one of the many varieties of ore that may be found in what could with all propriety be called the Masaba region, although it is not found in the area that is specially designated as such in this pamphlet.

It is the opinion of the State Geologist that the titanic rocks —which are the equivalent of the Cambrian formations, or nearly so, in the east—succeed the Kewatin chronologically, and represent the time of the primordial fauna. The preponderance of the carbonaceous slates, and the occurrence of lime and magnesia in the members of the group point to a great improvement of the oceanic life, supporting conditions, in spite of the occasional eruptive disturbances which broke periods of comparative tranquility. Is does not lie within the province of this pamphlet to go into the problems of the genetic origin of these ores, except in a very general way, as will be done hereafter, when it is necessary to illustrate a practical point.

The first group of ores to be considered are those which have been subjected to such marked development during the past few months, that is the carbonate ores, which occupy approximately an intermediate position, geographically, between the non-titanic magnetites on the northwest and the impure jaspilitic on the southwest. Until recently, the special features of some of these deposits were, in a measure, only speculative.

Since the exploitation on the Masaba range proper has been confined to but a very few months, and the opportunities for pit work and inspection have been afforded to the State Geologist

only within the last six months, it is difficult to find in the reports as full details as are desirable; but as will be seen further on, existing verified information, already printed, has been very kindly supplemented by Prof. H. V. Winchell, who, when asked to give a succinct and non-technical statement, said:

"The rocks of the Masaba range belong to one of the oldest geological formations, and consisted originally of a jasperitic quartzite, resting on the oldest rocks. Above the ore, lying horizontally, are graphitic and silicious slates. In their present aspect the hematite ores are fine examples of chemical change and replacement of some of the constituent elements of the original rock. That such action was possible is due to the fact that these Taconic rocks have never been covered by the more recent formations—the Silurian, the Devonian, the Carboniferous, etc., and this process of chemical alteration has resulted in extensive and remarkably rich deposits. Atmospheric waters percolating through the exposed rocks, combined with a certain amount of carbonic acid have dissolved the silica of the original jaspery rock, and deposited in its place the iron ore. Some of the original jaspery bands are still to be found in the hard streaks, while the result of the chemical replacement is to be seen in the soft and red ores."

The hematite ores of the Masaba range are very similar to those of the Gogebic, in structure, origin and other general features, with the one exception of dip. Those of the Gogebic have an angle nearly vertical, and require deep and expensive mining, while those of the Masaba are nearly horizontal, lie close to the surface, and as will be discussed at length hereafter, are amenable to the cheapest methods of mining. While there hardly seemed credible to anybody, when the testpits began to reveal both the richness and the volume of the ore, the vastness of the discovery that had been made, the presence of an ore body, perhaps equal in volume to the Gogebic, and corresponding closely to it, was suspected by the State Geologist, Prof. N. H. Winchell, some years ago, as is attested by the fact that in discussing the genetic relations of the ores of the Taconic, (in Bulletin No. VI., p. 134,) he says:

"The ore of the carbonated group (No. 3) in Minnesota, is at present entirely a hypothetical possibility. It seems to be that which so largely developed the Penokee-Gogebic range on the south side of the lake, and should it be found in Minnesota, it is to be supposed that a conjunction of circumstance similar to that described by Prof. C. R. Van Hise for Wisconsin would also be found.

Briefly stated, there are three of those conditions which seem to be essential to the occurrence of ore of like kind and genesis on the north side of the lake, viz: A considerable thickness of carbonated strata, preferably largely of siderite, but possible of lime and magnesia. 2. A cutting of those strata by perpendicular eruptive dikes the more numerous the better, prevailing in one direction. 3. The tilting of the strata, with their contained dikes, in a direction parallel with the prevailing direction of the dikes. It would require, according to the theory of Irving and Van Hise, only a lapse of time, and a continuance of natural

metoric force to produce ore along the troughs formed by the dikes and the strata."

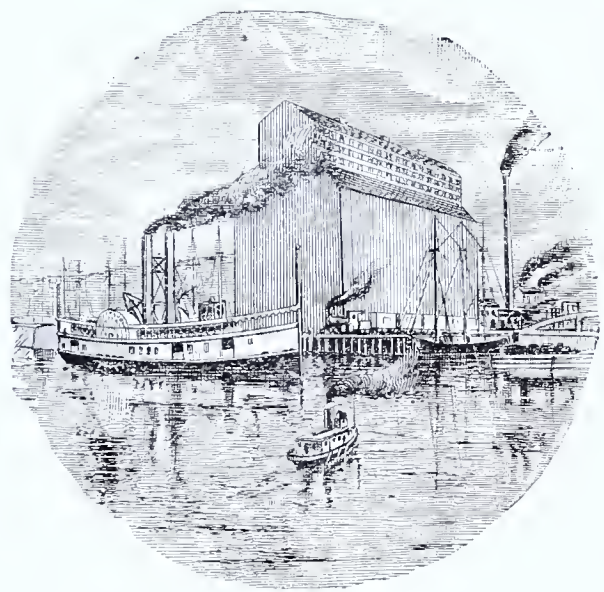
The concentration of the ore into trough formations is undoubtedly the way in which the ores of the Masaba were deposited, but as on that range the strata of the Taconic, not having been cut by dikes, and tilted but slightly, the troughs formed were of correspondingly greater area, which not only accounts for the vast extent of this ore body; but as there was a correspondingly greater surface for the atmosphere to act upon during the formative period, it probably accounts for the extreme richness of the ore as well.

It is an interesting fact, that, under this view of the case, the heel of the deposit will show even greater richness than the toe, or feather edge, where most of the work is now being done. It may be equally true, under this hypothesis, that at a point much farther south than has been supposed, the series of troughs may be located, and equally valuable deposits found in townships that have not yet been suspected of mineral deposits. Toward the west, already some of the best finds are being made, and these are along the flexures and folds of the line of out-crop of the greenstone, which it makes upon itself in the general trend northeast and southwest. All of these things fully bear out the prophesy that was made by Prof. Winchell in the report just quoted, when he said (Sec. 3, p. 112), referring to the ores of the Taconic, and citing Masaba range, as the heading: "They are destined to play a very important part in the future development of the iron industry of the State. They occupy four-fold the area that is occupied by the Keewatin ores; they are nearer the ore shipping points as well as the iron-using markets. On account of this high promise of future productiveness they are described at length in this bulletin." And again (ibid, p. 60): "There can be no reasonable doubt that in Minnesota, about the western and northwestern confines of Lake Superior basin, and extending westward to the Mississippi river, there will yet be mined in the Masaba range, even greater quantities of hematite than have been taken from that marvel of mining districts, the Penokee-Gogebic range, which blazed out with such a brilliant record only a few years ago."

The non-titanic magnetites come up next for consideration. As yet, they have not received very much attention, except at the hands of a few well-posted iron men, who are keeping abreast of the modern methods of mining, and the possibilities that lie in the recently discovered processes of magnetic concentration, treated of further on in this pamphlet. It is a singular fact that although these were some of the first ores to attract attention on the Masaba range, and the analyses given hereafter were made years ago, this part of the deposit seems to have been eclipsed by the brilliant developments of the Vermilion range, just as was the central portion of the range where there is now so much activity. Samples taken from pits twenty-seven feet deep show a remarkably good ore, the analysis made by Mr. Campbell, of the Columbia School of Mines, given elsewhere, being away above the average as a manganese ore. The other samples that have been taken from this portion of the range from time to time have

all been equally satisfactory. At present, the locality is far from the existing or projected lines of railroad, but it will eventually become one of the most important producing points on the range.

Of the two other groups there need be little said. The titanic ores are not now available for anything except the electrical concentration treated of farther on, and there has been not enough development of the second class to definitely determine their value. Both present interesting problems for the future.



BIRDSEYE VIEW SHOWING MINNESOTA POINT.

# General Excellence of Masaba Ores.

THE comparative grade of excellence which is maintained by the ores of the Masaba range when contrasted with those of other parts of the Lake Superior region, as well as with the ores mined in other localities seems to quite justify most of the claims that have been made for these new mines, as will be readily seen by a comparison of the tabulated analyses that are given hereafter. In the preparation of this table the utmost effort has been made to secure as many accurate assays from chemists of known repute as was practicable, and which were made from samples taken by disinterested parties at different depths of the various test pits and other openings so that a general average that would fairly represent the run of the mines might be secured. The recognized grades of iron ores of high standing throughout the country is, as a rule, only reached when repeated assays from totally different sources compiled often enough to demonstrate a fair uniformity which corresponds to the practical results attained when the test of the furnace had actually taken place. It is true of the Masaba range, as of all other iron districts, that there are decided differences in the quality of the ore taken from different points in the same deposit, and that care and careful judgment must be constantly exercised in sorting the grades for different specific purposes. Much of the ore that lies up toward the northern outcrop of the range is of a quality inferior to that found toward the heel of the deposit, and to the southward. It will never be mined for shipment with the other and richer grades by practical mining men. It was not possible, however, in getting in a limited time as large a number of analyses as were necessary to convey an adequate idea of the extent of the bed, to always make this discrimination, and catalogue the higher and lower grades separately, as they will really be worked; and the general average for the Masaba range is thereby correspondingly lowered, while at the same time, the different conditions, and the longer time that the ore bodies of other states and localities have been worked, has made it possible in those cases to obtain more thoroughly classified data. With this explanation, it is hoped that what was unavoidable, but is, in fact, a positive discrimination against the range will be understood. It makes the estimates and conclusions only more conservative, and the average is high enough even as it stands to bear a most favorable comparison.

It is assumed that many of the readers into whose hands this pamphlet will come know only in a very general and non-scientific way the best requirements of iron ore to make it of practical, and consequently of mercantable value. A simple and non-technical explanation of some of the conditions may not be out of place.

A large proportion of the iron that is mined each year is destined for eventual convertion into steel. The first treatment that the ore undergoes after proper sorting, is at the blast furnace,

where the presence of limestone and similar flux, under the influence of the high temperature carries off most of the impurities in a slag, and the molten metal, cast into bars, becomes the pig iron of commerce. It next goes to another establishment, which turns the iron into steel, and changes so many of its characteristics, generally known as the "acid," or Bessemer process, from the name of its inventor. One of the elements which is found closely associated with iron in its natural state, is phosphorus' and it is extremely difficult of elimination, always remains in the pig, and for some complex chemical reasons, interferes with the subsequent operation, which gives the real value to the finished product. Its presence thus renders the iron incapable of fulfilling its most useful offices as steel through the medium of the simplest, most economical, and hence the most valuable of metallurgical methods. When pig contanis phosphorus above a certain per cent, it may be used for castings; but it constitutes a low grade, and it is a commodity that is decreasing in value each year. There is an abundance of ore which will make such iron. There is, however, a comparative scarcity of the ore which is used for steel, and the demand for it is increasing as the latter form of the metal supplants its older brother.

Iron ores have, therefore, an increased or decreased value, as they are "High Phosphorus" or "Low Phosphorus," the former containing over six hundredths of one per cent., being inadapted to the Bessemer process; the latter falling under that limit and being available. The rule usually adopted to determine these conditions is that of instituting a comparison between the integral figures expressing the metallic iron in an analysis, and the decimal figures which indicate the proportion of phosphorus, reading the latter as an integer, however. If so taken, it reads higher than the integer of metallic iron, the ore is "high phosphorus" and non-Bessemer; if lower, the converse. That is to say, in other words, that to keep within the limit it must not have more than one thousandth part of phosphorus as against all the metallic parts of the ore. This determines its market value. The chemical laboratory thus becomes a court of last resort to the man who has found an iron mine, and on the unfailing accuracy of the revelations his fortunes rise or fall.

With this explanation the non-technical reader can readily estimate for himself the relative value of the Masaba range, in comparison with other portions of the country, of both Bessemer and non-Bessemer grades, if he bears in mind what was previously stated about the impracticability of separating in this work all of the Masaba grades that came from a stretch of territory over an hundred and thirty miles in length.

# One Hundred Analyses of Mesaba Ore.

And the Average Richness that They Give—Many of the Samples that Show the Lower Percentages of Iron were from Test Pits Near the Surface, in Places where the Ore was Much Increased in Richness as a Greater Depth was Reached.

| No. of Sample. | Location of Mine. | Metallic Iron. | Phosphorus. | Silica. |
|---|---|---|---|---|
| 1 | Biwabic | 66.80 | .016 | 2.16 |
| 2 | Biwabic | 61.95 | .034 | 5.75 |
| 3 | Biwabic | 59.45 | .010 | 13.62 |
| 4 | Little Messabi | 65.15 | .020 | 3.21 |
| 5 | Little Messabi | 57.62 | .032 | 11.45 |
| 6 | Little Messabi | 60.25 | .032 | 7.40 |
| 7 | Towanda | 62.85 | .043 | 8.36 |
| 8 | Towanda | 65.89 | .032 | 4.61 |
| 9 | Mallman | 65.54 | .028 | 4.72 |
| 10 | Cincinnati | 62.20 | .028 | 4.71 |
| 11 | Cincinnati | 59.91 | .011 | 6.84 |
| 12 | Cincinnati | 66.15 | .015 | 3.86 |
| 13 | Cincinnati | 67.10 | .040 | 2.85 |
| 14 | Kanahwa | 61.70 | .028 | 9.41 |
| 15 | Kanahwa | 66.10 | .014 | 3.27 |
| 16 | Kanahwa | 66.92 | .018 | 3.88 |
| 17 | Biwabic | 66.53 | .015 | 4.35 |
| 18 | Biwabic | 67.80 | .023 | 2.91 |
| 19 | New England | 64 10 | .024 | 5.87 |
| 20 | Lone Jack | 63.32 | .040 | 5.18 |
| 21 | Lone Jack | 62.90 | .038 | 4.73 |
| 22 | Charleston | 66.06 | .015 | 1.92 |
| 23 | Missabi Mountain | 65.05 | .026 | 2.46 |
| 24 | Missabi Mountain | 61.13 | .031 | 4.13 |
| 25 | Biwabic | 67.50 | .032 | 8.35 |
| 26 | Biwabic | 59.95 | .032 | 7.35 |
| 27 | Cincinnati—average of 7 samples | 61.95 | .036 | 6.31 |
| 28 | Cincinnati | 60.80 | .029 | 6.44 |
| 29 | Cincinnati | 63.20 | .031 | 4.10 |
| 30 | Biwabic | 67.50 | .031 | 5.10 |
| 31 | Washington Iron Co | 63.91 | .072 | 1.16 |
| 32 | Washington Iron Co | 63.27 | .052 | 1.49 |
| 33 | Lake Superior | 61.88 | .022 | ..... |
| 34 | Cincinnati | 63.60 | .060 | 3.19 |
| 35 | Cincinnati | 59.74 | .033 | 7.91 |
| 36 | Lake Superior | 63.40 | .015 | 5.50 |
| 37 | Lake Superior | 60.28 | .033 | ..... |
| 38 | Lake Superior | 60.30 | .041 | ..... |
| 39 | Lake Superior | 56.29 | .048 | ..... |
| 40 | Cincinnati | 59.75 | .032 | 8.35 |
| 41 | Cincinnati | 60.95 | .036 | 6,31 |
| 42 | Cincinnati | 60.80 | .029 | 6.44 |
| 43 | Cincinnati | 60.20 | .034 | 8.10 |
| 44 | Cincinnati | 62.55 | .051 | 3.14 |
| 45 | Biwabic | 67.50 | .010 | 4.15 |
| 46 | Kanawha | 64.45 | .050 | 3.32 |
| 47 | Little Messabi | 62.40 | .026 | 4.80 |
| 48 | Biwabic | 55.25 | .039 | 7.36 |
| 49 | Biwabic | 61.95 | .092 | 2.92 |
| 50 | Canton | 60.65 | .105 | 2.09 |
| 51 | Canton | 60.75 | .065 | 1.85 |
| 52 | Canton | 59.15 | .048 | 4.31 |
| 53 | Missabi Range | 65.60 | .017 | 4.10 |
| 54 | Missabi Range | 66.70 | .019 | 4.16 |
| 55 | Missabi Range | 56.45 | .054 | 5.83 |
| 56 | Canton | 60.78 | .065 | 1.88 |
| 57 | Canton | 61.65 | .105 | 2.09 |
| 58 | Washington Iron Co. | 63.91 | .072 | 1.16 |
| 59 | Washington Iron Co | 63.27 | .052 | 1 49 |
| 60 | Lake Superior | 61.88 | .022 | 2.46 |
| 61 | Cincinnati | 63.60 | .060 | 3.19 |
| 62 | Cincinnati | 59.74 | .033 | 7.19 |
| 63 | Lake Superior | 63.40 | .015 | 5.30 |
| 64 | Lake Superior | 60.28 | .033 | 4.13 |
| 65 | Lake Superior | 60.30 | .041 | ..... |
| 66 | Lake Superior | 56.29 | .048 | ..... |

| No. of Sample. | Location of Mine. | Metallic Iron. | Phosphorus. | Silica. |
|---|---|---|---|---|
| 67 | Biwabic | 59.90 | .075 | 7.24 |
| 68 | Biwabic | 63.40 | .086 | 3.82 |
| 69 | Biwabic | 63 80 | .043 | 3.46 |
| 70 | Myrna | 62.00 | .021 | 7.64 |
| 71 | Mallman | 58.70 | .013 | 12.11 |
| 72 | Mallman | 54.25 | .020 | 18.52 |
| 73 | Mallman | 61.70 | .028 | 9.41 |
| 74 | Mallman | 58.50 | .023 | 14.03 |
| 75 | Mallman | 66.10 | .014 | 3.27 |
| 76 | Mallman | 55.60 | .023 | 16.81 |
| 77 | Mallman | 56.70 | .018 | 18.59 |
| 78 | Mallman | 66.92 | .018 | 3.88 |
| 79 | Mallman | 66.33 | .015 | 4.35 |
| 80 | Mallman | 67.80 | .023 | 2.91 |
| 81 | Chicago | 65.77 | .073 | 3.31 |
| 82 | Chicago | 66.45 | .049 | 3.30 |
| 83 | Chicago | 67.23 | .033 | 3.33 |
| 84 | Biwabic | 61.30 | .054 | 7.68 |
| 85 | Lake Superior | 65.50 | .030 | 4.01 |
| 86 | Ohio | 65.09 | .038 | 3.06 |
| 87 | Ohio | 66.05 | .028 | 3.36 |
| 88 | Ohio | 64.32 | .028 | 4.45 |
| 89 | Ohio | 65.90 | .058 | 3.60 |
| 90 | Ohio | 64.90 | .035 | 3.20 |
| 91 | Towanna | 64.61 | .035 | 2.20 |
| 92 | Towanda | 64.60 | .021 | 2.21 |
| 93 | Towanda | 55.10 | .012 | 1.12 |
| 94 | Towanda | 53.90 | .056 | 7.32 |
| 95 | Canton | 63.91 | .056 | 7.19 |
| 96 | Canton | 57.03 | .060 | 15.20 |
| 97 | Biwabic, | 65.75 | .050 | 6.10 |
| 98 | Canton | 60.65 | .105 | 2.09 |
| 99 | Missabi Mountain | 62.40 | .026 | 4.80 |
| 100 | Missabi Mountain | 63.91 | .056 | 7.19 |
| | General average | 62.52 | .037 | 5.44 |
| | Highest | 67.80 | | |
| | Lowest | 53.90 | | |
| | General mean | 61.44 | | |

The following table has been prepared by the selection of assays of such ores as would be mined and classed together by a practical mining man; and is here given to demonstrate by comparison with the tables afterward given how great is the excellence of the Masaba range ore as it will really be shipped. Even its low grade ores, and those which fall below the Bessemer limit, are, as will be seen, equal, if not superior, to ores that are being successfully worked in other states, even now; and with the improvements that are constantly being made in metallurgy, they will doubtless be used near at home, if they are not rich enough to justify the freight rates of a long haul:

### Five Ores of About the Same Grade—Averaged.

General Average.

| No. of Sample. | Name of Mine. | Iron. | Phosphorus. | Silica. |
|---|---|---|---|---|
| 1 | Lake Superior | 68.51 | .031 | 3.10 |
| 2 | Ohio | 66.95 | .028 | ..... |
| 3 | Chicago | 66.45 | .049 | 3.30 |
| 4 | Mallman | 66.92 | .018 | 3.88 |
| 5 | Chicago | 67.83 | .013 | 3.33 |
| | General average | 67.33 | .0278 | 3.40 |

Mean Average.

| | | | | |
|---|---|---|---|---|
| 1 | Lake Superior (highest) | 68.51 | .031 | 3.10 |
| 2 | Mallman (lowest) | 66.92 | .018 | 3.88 |
| | Mean average | 67.71 | .0245 | 3.49 |

In making comparisons with the analyses that follow, it should be borne in mind that the averages given are all general averages, except in the last table. There a mean average is used. It would lead to manifestly erroneous conclusions to compare the general average of a large number of samples with the mean average of a few, or vice versa.

COMPLETE ANALYSES OF THREE SAMPLES OF ORE FROM THE MALLMAN MINE.

| | No 1. | No. 2. | No. 3. |
|---|---|---|---|
| Iron | 60.76 | 62.35 | 66.73 |
| Manganese | .51 | .38 | .67 |
| Silica | 10.86 | 8.47 | 6.08 |
| Phosphorus | .016 | .017 | .01 |
| Alumina | 1.35 | 1.12 | .695 |
| Lime | trace. | trace. | trace. |
| Magnesia | .37 | .14 | .09 |
| Sulphur | absent. | absent. | absent. |
| Titaneum | absent. | absent. | absent. |
| Oxygen and Volatile matter | 26.06 | 26.82 | 27.74 |

As already stated, the general formation of the Masaba range more closely resembles that of the Gogebic than any other well known locality, and the fame of the mines there has been extending, year by year, as its out-put has increased. There is always a good demand for it, and it has proved a veritable bonanza for the holders of its properties. The following table and average of analyses of samples from the Colby mine, which has made millions for its owners, is taken from Bulletin VI., of the Minnesota Geological Survey:

## The Gogebic Range, Wisconsin.

TABULATION OF FIVE SPECIMENS FROM THE COLBY MINE.

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Iron and Manganese | 60.040 | 62.340 | 62.760 | 66.020 | 61.270 |
| Metallic Iron | 48.630 | 55.490 | 55.490 | 65.100 | 52.700 |
| Phosphorus | .083 | .070 | .070 | .042 | .075 |
| Silica | 6.080 | 2,680 | 2,685 | 8.840 | 1.820 |
| Manganese | 11.410 | 6.850 | 6.850 | .920 | 8.570 |

## The Menominee Range.

This, the Marquette, the Vermilion and the Gogebic produce almost all of the Lake Superior iron ore which is put on the market at present, and on these three ranges there are about 187 mines, which last year, according to a recent article in the Marine Review, amounted to 10,402,754 tons, which was a less aggregate by over two million tons than could have been shown two years ago, the falling off being due to the depression in steel, and the heavy cost of mining, a fact only cited here because it will be considered at some length elsewhere, and the comparison of these will be referred to. The following tabulation is also from the report just quoted, the average having been added by the writer. The showing is as follows:

| | Vulcan. | Cyclops. | Norway. | Quinnesec. |
|---|---|---|---|---|
| Iron | 63.93 | 60.47 | 58.94 | 67.05 |
| Silica | 6.86 | 3.38 | 12.27 | 4.80 |
| Phosphorus | .013 | .009 | .016 | .001 |

Average—Iron....62.49 Silica....6.80 Phosphorus.... .012

These are the two ranges that are said to most closely approach the Masaba range in quality, the ore of Marquette and Vermilion being slightly higher in metallic iron and lower in phosphorus. The following tabulation, taken from fourteen analyses of the ore from the Republic mine, as given by Swank, is taken as representative of the general run of the range, though it ought to be stated in this connection that some of the Champion ores show an analysis even a shade better grade than these as to Bessemer quality. In this case, as in the foregoing, the averages have been added to the table as originally printed:

## The Vermilion Range.

The ores which are mined on this range are those on which the highest encomiums have been passed by both scientists and iron men, and it is but slight derogation of the excellence of Masaba ores if the general average falls below that of the mines of which the State Geologist has said, in small capitals, and quite truly, doubtless, "An extensive comparison of the published grades of the principal ores of iron has demonstrated that the Keewatin ores of Minnesota, as produced from the mines at Tower and Ely, are purer than any iron ores mined to any extent in the world." Whether the cheapness of mining will not overcome this difference will be treated of under another head. The following analyses are inserted to show how fairly the Masaba ores compare with the purest of ores. The table is made up of sixteen samples taken by J. Blodgett Britton, Prof. Albert H. Chester, Charles E. Wright, S. P. Ely and others, and constitutes the original assays upon which the great Vermilion development was based:

ORIGINAL VERMILION ANALYSES.

| | Iron. | Silica. | Sulphur. | Phosphorus |
|---|---|---|---|---|
| No. 1, by Britton | 69.69 | ..... | ..... | .019 |
| No. 2, by Chester | 66.93 | 3.39 | .01 | .011 |
| No. 3, by Chester | 66.43 | 3.89 | none. | 6.000 |
| No. 4, by Chester | 65.22 | 3.45 | none. | .064 |
| No. 5, by Chester | 66.18 | 3.75 | none. | .039 |
| No. 6, by Wright | 66.71 | 2.40 | .018 | .072 |
| No. 7, by Wright | 67.60 | 1.35 | .009 | .027 |
| No. 8, by Etna Pa. F. Co. | 68.79 | 1.34 | ..... | .038 |
| No. 9, by Etna Pa. F. Co. | 68.34 | 2.14 | ..... | .053 |
| No. 10, by Etna Pa. F. Co. | 66.42 | 4.67 | ..... | .031 |
| No. 11, by Pittsb'rg B. S. Co. | 65.41 | 1.41 | ..... | .044 |
| No. 12, by Pittsb'rg B. S. Co. | 68.19 | 2.02 | ..... | .061 |
| No. 13, by Pittsb'rg B. S. Co. | 66.37 | 4.72 | ..... | .039 |
| No. 14, by Britton | 69.93 | .73 | ..... | .033 |
| No. 15, by Ely | 69.30 | ..... | ..... | .053 |
| No. 16, by Ely | 68.51 | ..... | ..... | .078 |

## Ores from the Marquette Range.

| ANALYSES. | Metallic Iron. | Phosphorus. | Silica. |
|---|---|---|---|
| No. 1 | 65.11 | trace. | ..... |
| No. 2 | 67.75 | .05 | ..... |
| No. 3 | 68.01 | trace. | ..... |
| No. 4 | 69.88 | .018 | ..... |
| No. 5 | 69.24 | ..... | 1.08 |
| No. 6 | 71.82 | ..... | .84 |
| No. 7 | 68.40 | .08 | .86 |
| No. 8 | 68.23 | .15 | 3.53 |
| No. 9 | 65.86 | .073 | 4.63 |
| No. 10 | 69.89 | .06 | 2.02 |
| No. 11 | 67.55 | .045 | 2.03 |
| No. 12 | 68.00 | .05 | ..... |
| No. 13 | 68.40 | ..... | ..... |
| No. 14 | 70.60 | ..... | 1.10 |
| Average | 68.40 | .053 | 2.07 |

## The Masaba Magnetites.

These ores, as has already been stated, have attracted but little commercial attention as yet, though they were noted early in the prosecution of the geological survey, and were among the first to be tested in the early history of the range. What may be found for furnacemen when they are made available may be seen by the following analyses:

No. 1.

Analysis by Mr. Campbell, of the Columbia School of Mines, made in 1872. Sample from 60-12:

| | |
|---|---|
| Oxide of Manganese, | 86.863 |
| Silica, | 1.318 |
| Lime, | 2.041 |
| Magnesia, | 1.299 |
| Alumina, | .633 |

No. 2.

Analysis by J. Blodgett Britton, of Philadelphia, 1872:

| | |
|---|---|
| Pure Metallic Iron, | 58.74 |
| Oxygen with the Iron, | 22.38 |
| Oxide of Manganese, | 1.77 |
| Silica, | 13.28 |
| Lime, | 1.18 |
| Magnesia, | .98 |
| Alumina, | .62 |
| Phosphorus, | .23 |
| Sulphur, | trace. |
| Water, | .45 |

No. 3.

Edward R. Taylor, Chemist, Cleveland, Rolling Mill Co., 1872:

| | A. | B. |
|---|---|---|
| Insoluble Silicious matter, | 8.70 | 4.06 |
| Metallic Iron, | 63.13 | 65.62 |
| Iron Protoxide, | 22.61 | 23.34 |
| Iron Sesquioxide, | 65.04 | 67.73 |
| Phosphoric Acid, | .37 | .18 |
| Lime, | 1.69 | 3.15 |
| Magnesia, | .52 | .50 |
| Manganese Oxide, | .70 | .64 |
| Alumina, | .22 | .35 |

## Ores of Other States.

During the census year there were in operation furnaces in twenty-four states, all of which have greater or less deposits of iron, of variable quality, within their borders. Some of those which manufacture iron most largely do not consume any large proportion of their own ores, but for various reasons use those of other localities. At quite a number of the eastern furnaces, a low grade of native ore is graded up with those that come from the Lake Superior region, until it is rich enough to make the class of iron desired to be produced, and this is one of the sources of demand for rich ores like that of the Vermilion range.

The states producing ore at the period referred to were as follows:

Alabama,
Connecticut,
Delaware,
Georgia,
Kentucky,
Indiana,
Maine,
Maryland,
Massachusetts,
Michigan,
Missouri,
New Jersey,
New York,
North Carolina,
Oregon,
Ohio,
Pennsylvania,
Tennessee,
Texas,
Vermont,
Virginia,
West Virginia,
Wisconsin.

For the purpose of further comparison analyses of the iron ores of most of them, selected from various standard sources, will be given in the order just named. In some cases the assays are from a number of selected samples, and have been averaged so as to fairly represent the grade of the region. It was found more convenient in others to present a tabulation of a number of standard samples and let the reader make his own deductions. Farther on in this section of the pamphlet will be found a table giving the maximum and minimum iron value of all of them, together with an average struck from those figures, and this will be found convenient when an average has not been made in these tables.

### Alabama Ores.

The following tables give both the magnatite analyses and a tabulation and average of three of the hematites:

| | M'gnatite | Hematite | | | |
|---|---|---|---|---|---|
| | No. 1. | No. 1. | No. 2. | No. 3. | Av. of Hematites. |
| Metallic Iron | 47.43 | 44.71 | 61.24 | 56.45 | 57.43 |
| Phosphorus | .147 | .50 | .03 | .34 | 2.90 |
| Silica | 13.00 | 33.22 | 5.54 | 16.80 | 16.52 |

"The process of roasting the brown ores of Alabama is for the purpose of freeing them from water, and also for the separation of all earthy matter. The ores will average fully 10 per cent of water. * * * Roasting increases their richness perceptibly. An analysis will clearly illustrate this fact."

DRIED AT 212°.

| | Raw. | Roasted. | Washed. |
|---|---|---|---|
| | Per Cent. | Per Cent. | Per Cent. |
| Metallic Iron | 46.12 | 60.01 | 51.24 |
| Silica | 14.85 | 3.16 | 11.03 |
| Alumina | 9.13 | 1.93 | 8.43 |
| Phosphorus | .013 | .059 | .164 |

Raw brown hematite dried at 212° will average: Iron, 49.812; phos., .466; Silica, 13.960.

## CONNECTICUT IRON ORES.

The ores of this state are so lean that they have not been worked for several years, nevertheless for the sake of completeness a general idea should be given of them. The following analyses are after Bayard T. Putnam, in the Tenth Census report:

| | No. 775. | No. 776. | No. 778. | No. 779. | No. 780. |
|---|---|---|---|---|---|
| | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. |
| Metallic Iron | 35.10 | 40.03 | 44.04 | 44.38 | 48.02 |
| Phosphorus | 0.128 | 0.113 | 0.100 | 0.103 | 0.120 |

The following tabulation is from Swank's manual, with the average added as above:

THE CONNCTICUT ORES.

| | Iron. | Phospho-rus. | Silica. |
|---|---|---|---|
| Davis Mine | 53.00 | .014 | 7.58 |
| Chatfield Mine | 54.69 | .219 | 6.63 |
| Old Hill Mine | 51.45 | .250 | 10.48 |
| Average | 53.01 | .161 | 6.23 |

## THE ORES OF GEORGIA.

The following three samples give an idea of the characteristic ores of the "Cracker State," and are from the Tenth Census:

| | No. 442. | No. 443 | No. 444. |
|---|---|---|---|
| | Per Cent. | Per Cent. | Per Cent. |
| Metallic Iron | 47.21 | 54.71 | 49.50 |
| Phosphorus | 1.134 | 1.256 | 1.537 |
| Manganese | 0.30 | 0.25 | 1.69 |

## IN MARYLAND.

A considerable amount of foundry pig is made from ores like the following:

CHARACTERISTIC MARYLAND ORES.

| | Metallic Iron. | Phosphorus | Phosphorus to 100 Parts Iron. |
|---|---|---|---|
| Carbonate, Baltimore County | 46.23 | 0.127 | 0.275 |
| Roasted Carbonate, Prince George County | 46.25 | 0.108 | 0.234 |
| Magnatite, Carroll County | 64.44 | 0.243 | 0.377 |
| Limonite (unwashed), Frederick County | 41.41 | 0.665 | 1.606 |
| Limonite (washed and screened), Catoctin Furnace | 41.55 | 0.188 | 0.452 |
| Fossil Ore | 46.59 | 0.217 | 0.466 |

## THE KENTUCKY ORES.

Kentucky iron is made from ores taken in three different districts. That in the southwestern part of the state embracing Lyon and Trigg counties, known as the Cumberland River district, the Kentucky and the Red River district, near the center of

IN DULUTH HARBOR.

the state, and the Hanging Rock region, at the extreme northwest corner. The following analyses fairly represent

TYPICAL KENTUCKY ORES.

| | Cumberl'nd River Region. | Kentucky and Red River Region. | Hanging Rock Region. |
|---|---|---|---|
| | No. 1. | No. 1. | No. 1. |
| Metallic Iron | 47.25 | 50.65 | 51.101 |
| Phosphorus | 0.129 | 0.183 | 0.173 |
| Phosphorus Ratio | 0.254 | 0.361 | 0.339 |
| | No. 2. | No. 2. | No. 2. |
| Metallic Iron | 48.81 | 44.51 | 36.18 |
| Phosphorus | 0.104 | 0.282 | 0.341 |
| Phosphorus Ratio | 0.213 | 0.634 | 0.943 |
| | No. 3. | No. 3. | No. 3. |
| Metallic Iron | 49.23 | 51.58 | 35.36 |
| Phosphorus | 0.099 | 1.094 | 0.260 |
| Phosphorus Ratio | 0.201 | 2.121 | 0.735 |

IRON ORES OF MASSACHUSETTS.

| | Hudson Iron Co., Berkshire Co. | West Stockbridge, Berkshire Co. | Richmond, Berkshire Co. |
|---|---|---|---|
| | Per Cent. | Per Cent. | |
| Iron | 40.71 | 47.52 | 39.12 |
| Phosphorus | 0.142 | 0.187 | .0248 |
| Phosphorus Ratio | 0.394 | .0349 | .0634 |

THE MISSOURI ORES.

Tabulated from several analyses, given by Swank. Averages of both surface and bluff ores:

| | Iron | Phosphorus. | Silica. |
|---|---|---|---|
| Iron Mountain | 67.02 | .022 | 2.66 |
| Pilot Knob | 62.20 | .009 | 9.22 |
| Simmons Mountain | 68.69 | .016 | 1.41 |
| Average | 65.97 | .015 | 4.43 |

NEW YORK ORES.

Average analyses of the mines, figures in each case being themselves averages which fairly represented the mine.

| | Iron | Phos. | Silica. |
|---|---|---|---|
| Port Henry Mines, average of 10 samples | 56.54 | .040 | 9.58 |
| Sterling Mines, Orange County | 64.85 | .118 | 6.18 |
| Tilly Foster, Putnam County | 67.41 | .050 | 11.75 |
| Average | 62.93 | .069 | 9.17 |

NEW JERSEY ORES.

Average of tabulation of two mines in Sussex county:

| | Iron. | Phosphorus. | Silica. |
|---|---|---|---|
| Hill Vein | 69.50 | .03 | 18.27 |
| Furnace Vein | 65.40 | .78 | 1.05 |
| Average | 67.45 | .40 | 9.66 |

Several analyses made at the Hibernia Mines show metallic

iron 61.00, and phosphorus 0.3524. The general average of the official reports from the State was, metallic iron, 48.60 to 57.49 per cent; phosphorus, 0.021 to 0.113.

### North Carolina Cranberry Ore.

| | No. 1. | No. 2. | No. 3. | No. 4 | No. 5. |
|---|---|---|---|---|---|
| Magnetic Oxide of Iron | 94.37 | 91.45 | 85.77 | 80.77 | 91.89 |
| Oxide of Manganese | .26 | .06 | .24 | 1.42 | .32 |
| Alumina | .42 | .77 | .11 | .52 | 1.03 |
| Lime | .43 | 1.01 | .72 | ..... | 1.06 |
| Magnesia | .36 | .53 | .33 | ..... | .23 |
| Water | ..... | .44 | 1.53 | 8.21 | 1.15 |
| Silica, pyroxene, etc | 4.16 | 5.74 | 11.48 | 9.08 | 4.02 |
| Sulphur | ..... | ..... | ..... | ..... | .25 |
| Phosphoric acid | ..... | ..... | ..... | ..... | trace |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Metallic Iron | 68.34 | 66.32 | 61.98 | 58.49 | 66.53 |

### The Oregon Ores.

The following tabulation of Oregon ores was made from the report of Bayard T. Putnam to the United States Goological Survey:

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Metallic Iron | 44.71 | 54.19 | 45.40 |
| Phosphorus | 0.666 | 0.392 | 0.576 |
| Phosphorus Ratio | 1.490 | 0.723 | 1.269 |

### The Ohio Ores.

The ores of Ohio consist of unaltered carbonates as grey and and blue limestone, vein and kidney, or limonites in vein and kidney, and of soft red hematites. The following table gives an average analysis of each of these principal varieties:

| | Grey Limestone ore, | Grey Limestone Kidney. | Soft Red Hematite. | Limonite Red Limestone vein. | Limonite Kidney. | Black Band Ore. |
|---|---|---|---|---|---|---|
| Iron | 36.56 | 34.27 | 51.97 | 47.23 | 41.40 | 45.68 |
| Phosphorus | 0.151 | 0.049 | 0.072 | 0.240 | 0.211 | .568 |
| Phosphorus Ratio | 0.413 | 0.143 | 0.139 | 0.508 | 0.476 | 1.240 |

### The Pennsylvania Ores.

While the Keystone State has been for many years a very heavy producer of Iron Ores, the best known of her hundreds of mines is the Cornwall, which shipped over 10,000,000 tons up to 1888. The brown hematite ores of Susquehanna, Shenango, Cumberland, Lebanon counties, and in the Lehigh Valley, average about 40 per cent. The average assays of Eastern Pennsylvania were as follows:

| | High. | Low. | Average. |
|---|---|---|---|
| Iron | 58.50 | 28.10 | 46.09 |
| Sulphur | ..... | ..... | .025 |
| Phosphorus | 3.135 | 0.25 | 0.344 |
| Manganese | 9.28 | trace | 1.275 |
| Insoluble Residue | .... | ..... | 17.16 |

The Cornwall, which is the king of the magnetite mines, shows the following figures on samples selected by Mr. James M. Swank, to give a fair representation of the ore:

| No. | Iron. | Phosphorus | Silica. |
|---|---|---|---|
| 1 | 59.22 | .032 | 11.08 |
| 2 | 46.42 | .004 | 28.00 |
| 3 | 52.66 | .002 | 18.24 |
| 4 | 65.95 | .007 | 2.20 |
| 5 | 39.38 | .001 | 37.86 |
| 6 | 64.99 | .002 | 3.84 |
| Average | 54.60 | .0008 | 16.87 |

### The Tennessee Iron Ores.

The ores of this state may be classed as limonite, specular fossil, dyestone and kidney limonite. The following are average, analyses of each variety:

| | Limonite McMinn Co. | Limonite Queens Station Johnson Co. | Specular. Cannon Bank. Sullivan Co. | Fossil Hill Bank McMinn Co. | Dyestone Ore. Knox Co. | Limonite. Pinion Bank. |
|---|---|---|---|---|---|---|
| Metallic Iron | 45.47 | 57.65 | 63.84 | 51.42 | 49.89 | 53.27 |
| Phosphorus | 0.724 | 0.154 | 0.022 | 0.822 | 1.652 | 0.340 |
| Phosphorus Ratio | 1.592 | 0.267 | 0.034 | 1.599 | 3.311 | 0.638 |

### The Virginia and West Virginia Ores.

These, like most of the others that have been cited, are almost uniformly non-Bessemer, and are given to show how among all the iron producing states, the Lake Superior region leads the continent, as Minnesota leads the lake region with her unparalleled Vermilion, and as the Masaba range, although with ore that is a shade less rich, leads the Vermilion, because of the exceeding cheapness with which it can be mined and put on the market. This latter fact will be demonstrated hereafter. These are analyses of some of the leading Virginia mines:

| | Iron. | Phosphorus | Phos. Ratio |
|---|---|---|---|
| Cripple Creek, Yellow Limonite | 54.21 | 0.179 | 0.330 |
| Cripple Creek, Red Ore | 53.14 | 0.117 | 0.220 |
| Low Moor Mine | 42.70 | 0.761 | 1.782 |
| Great North Mountain, Liberty Furnace | 41.71 | 0.114 | 0.273 |
| Van Buren Furnace | 35.26 | 0.066 | 0.187 |
| Brown Hill Furnace | 54.56 | 0.053 | 0.097 |

## Some General Comparisons.

Before dismissing the subject of the general excellence of the ores of the Mesaba Range, it will be interesting to examine in a less detailed way the relative value of the iron ores of different states and countries. As the partial analyses given above have all dealt with the relative proportion of phosphorus, and shown clearly where the ore was within the Bessemer limit, and where it was not, this comparison of relative values can be made most compactly and expeditiously by dealing only with the percentage of metallic iron, and leaving all other elements out of the figures. The averages that have been annexed to many of the tables of analyses given, have, of course, only applied to those samples of ore there assayed, and varied considerably, as will be seen by comparing the average of the one hundred analyses from the entire Masaba Range with the average ob-

tained on the tabulation of the six samples from the Mallman mine. All results obtained from a small group in this way are always more or less individualized, and can not be relied upon for final judgment any farther than can a handful of citizens be taken as absolute exponents of the character of a state or nation. They may be indicative; but nothing more. There is a way to reach the real facts as near infallibly as lies within human ken. It is by aggregate. This is the way to get at the real value of iron ores. All of the mines in operation keep a chemist busy analyzing several hundred specimens per month; more are made at the furnaces where the output is consumed, while perhaps another set has been made meanwhile by the agent who handled the ore. When the results of all of these are collated, the general run of the mine is pretty well established. The same is true of states, and of countries.

The following table, for the use of which the writer is indebted to the courtesy of Maj. T. B. Hoover, of Duluth, presents the highest and lowest percentages of iron found in the ores of various localities, and after its preparation was sent to Mr John Birkinbine, the well known iron authority and expert. On its submission, Mr. Birkinbine made several changes in it from his own memoranda, and approved the rest, so that the figures are substantially his own. The table as furnished the writer contained only the highest and lowest assays. He computed and added the general mean, and arranged the states in alphabetical order to correspond with the preceding portion of this chapter. The following is the table:

RELATIVE VALUE OF IRON BY STATES.

| STATES. | Highest | Lowest | Mean |
|---|---|---|---|
| Alabama | 57.91 | 38.23 | 48.57 |
| Connecticut | 55.06 | 40.00 | 47.53 |
| Georgia | 56.25 | 38.48 | 47.36 |
| Kentucky | 50.00 | 35.00 | 42.50 |
| Maine | 58.10 | 20.70 | 39.40 |
| Maryland | 45.70 | 23.12 | 34.42 |
| Massachusetts | 45.00 | 31.00 | 38.00 |
| Michigan | 62.93 | 52.64 | 57.79 |
| Missouri | 67.00 | 45.00 | 56.00 |
| New Jersey | 60.66 | 48.00 | 54.33 |
| New York | 68.24 | 50.00 | 59.12 |
| North Carolina | 44.89 | 36.01 | 40.45 |
| Ohio | 54.65 | 30.20 | 42.42 |
| Pennsylvania | 58.50 | 28.10 | 43.25 |
| Tennessee | 57.33 | 26.60 | 41.96 |
| Vermont | 45.00 | 32.00 | 38.50 |
| Virginia | 62.90 | 44.00 | 53.45 |
| West Virginia | 52.60 | 31.19 | 41.89 |
| Wisconsin | 65.18 | 51.49 | 58.35 |
| MINNESOTA | 69.28 | 51.49 | 60.39 |

IN OTHER COUNTRIES.

| | | | |
|---|---|---|---|
| Sweden | 65.00 | 62.05 | 63.54 |
| Africa | 60.23 | 53.67 | 56.75 |
| Elba | 60.91 | 56.50 | 58.70 |
| Greece | 52.53 | ..... | ..... |
| England | 62.70 | ..... | ..... |

DULUTH HIGH SCHOOL.

LONGFELLOW SCHOOL, WEST DULUTH.

# The Cost of Mining on the Masaba Range.

AS HAS already been indicated, the ores of the Masaba range resemble more closely those of the Gogebic than of any other known locality, both in geological features and horizon, and in chemical composition. They lie in what is presumably the same formation, show similar features of country rock, exhibit like variations in color, texture and richness, and have in fact, all the characteristics of the Wisconsin deposit, save one, that of position. The greatest advantage of the range lies in this one most important distinction, and to it are referable some of the greatest advantages that are claimed for the mines which have just been opened, as well as for those that are being located almost every week.

The strata in which the deposits of the Gogebic are found are nearly vertical, the dip being so great that by shafting alone can the ore be procured. The expense of deep mining is well understood. It entails not only the necessity for elaborate and costly hoisting machinery, but in the lower levels subterranean streams are always encountered, and pumping must be kept up constantly, adding much to the cost of maintaining the plant. The shafts at the various mines on the Gogebic range are from two to five hundred feet in depth, and the hoisting plants that are there in use cost in the neighborhood of fifty thousand dollars. The volume of water raised is about ton for ton to the ore produced, and the tender service on the pumps is no small item in the bill of running expense. Another item is the maintenance of artificial ventilation. From the bottom of the shaft, the drifts and gangways that lead to the working face must all be bratticed, more or less, to keep up a good air current, and in addition to all of this there is considerable timbering to be done to make the works absolutely safe. In the mines where rock drills actuated by compressed air are used, the exhaust of the drill keeps the air comparatively pure, but sole reliance cannot be placed on any such capricious means of ventilation, and there is hardly a mine that has not a furnace or fan at its upcast.

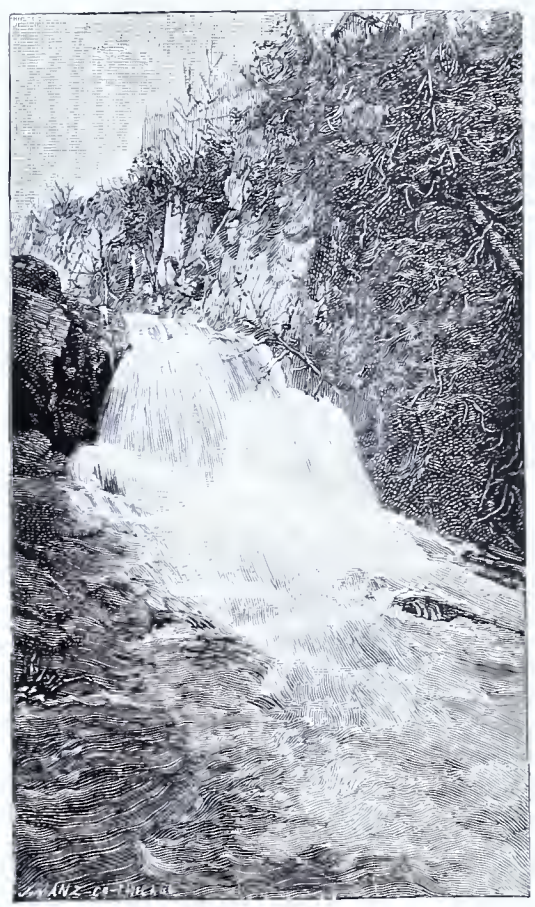
A gentleman who is intimately acquainted with most of the mines on the range, assured the writer that $1.29 was about as cheap as ore could be mined and raised on the Gogebic. A safe figure for the ore on the cars, was, he said, about $1.50 per ton. These figures he based upon his personal experience in connection with one of the most noted mines of the range, where every device of labor-saving machinery that capital could command, and every facility for handling the ore was in use. With some of the other mines that have not such completeness of plant, it is probable that the mining figure may be a trifle higher.

Another estimate coming from equally good authority has been given as the cost of mining ore of the largest and best known mines on the Gogebic range, as follows:

| | |
|---|---|
| Timbering, | $ .40 |
| Mining, | .50 |
| Pumping, | .10 |
| Exploring, | .15 |
| Handling and loading, | .15 |
| Cost per ton, | $1.30 |

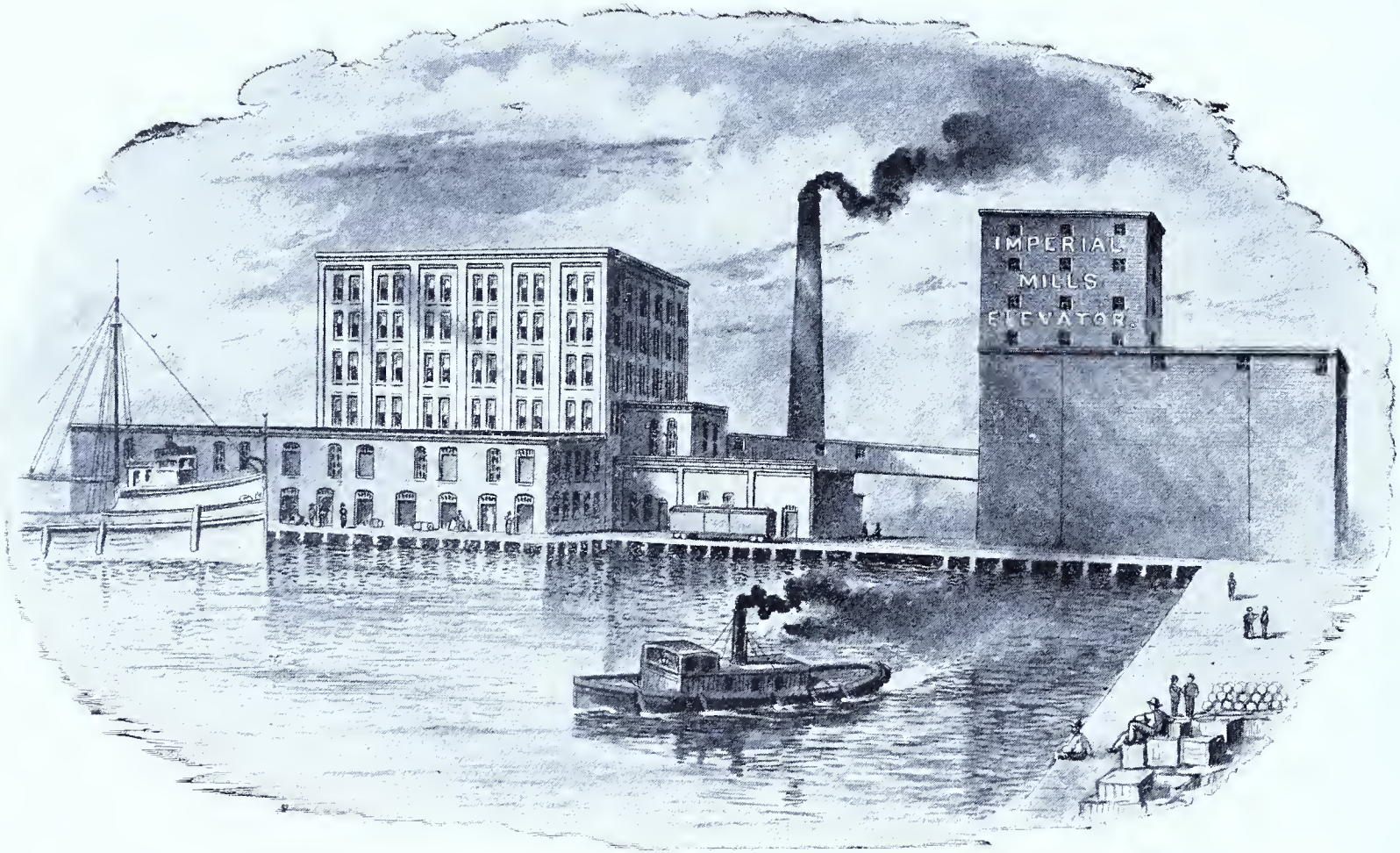
All this is in very strong contrast to what will be found true on the Masaba range, when the mines commence shipment. As has already been stated, the principal difference between the two ranges is in the position of the ore. The deposit on the Masaba has so slight a dip, and lies so comformably to the strata that it might almost be characterized as a blanket formation. This would not be by any means true, as has been shown in the brief geological description of it. It lies in well defined troughs where it was originally deposited by the waters that destroyed the mother rock; but these troughs are almost horizontal, and the drift that has covered the beds in subsequent ages is comparatively shallow. Moreover, the topography of the country is such that the mines now opened are located most advantageously for the cheapest method of mining known—that of stripping, and loading from the working face.

The ore, unlike that of the Gogebic, which is dense and solid, is rather soft, and parts easily with a sort of irregular conformity to the banded lines that represent the original jaspilyte and when blasted shatters in every direction, coming away as a sort of large gravel, that can be easily handled by a steam shovel, and this will be the method pursued in a number of cases where work is already under way. On one of the properties which slopes gently back from Embarrass Lake a cut will be made five hundred feet from the northernmost test pit. At this point, the contours are such that within a rod or two from the point where operations are begun the surface of the ore will be reached, and as the work progresses, the shovel that did the stripping will mine the ore also. The cut will be about sixty feet wide at the outset. Similar methods are to be adopted at other points along the range, and by the time that the railroads are ready to receive the ore, there will be generous stock piles waiting.



CASCADE ON PARTRIDGE RIVER.

The cost of the stripping compared with the ore that will be brought in sight is very slight indeed. Before the railroads reach the region, the ore can be stripped for forty cents a cubic yard.




IMPERIAL FLOUR MILL.

# Railroads and Transportation Facilities.

FIRST discoveries of iron ore on the Masaba range were made about 1875, but at that time the importance of the find was not realized, and all attention centered on the deposits of the Vermilion, which were supposed to be then, as they have since proved, the richest and purest iron ores found in quantities anywhere. The Masaba region was an almost totally unexplored territory so far as geology was concerned; and only the lumbermen who logged along its streams and lakes, and a few hunters, fishermen, and old settlers knew anything of its local geography and topography. It was supposed that if iron did exist among its hills to any extent, the formation was the same as that of the Vermilion range, and as the latter possessed the richer ore, all effort to interest eastern capital toward development was directed toward that locality. The story of these first attempts to get a practical development of the rich mineral resources of northwestern Minnesota is one of vicissitude, disappointment and vexation. As has been stated, the first discovery of ores on the Vermilion range had been made in 1865, by George R. Stuntz, formerly surveyor of St. Louis county, who, during a brief sojourn in the region noticed the outcroppings near the location of the mine which later on bore his name. It is not surprising that, at that time, such a discovery in a region far away from civilization, did not awaken any peculiar enthusiasm. It was not until 1875 that anything was done toward developing the mineral resources of the range. During that year, George C. Stone, who was then a resident of Duluth, and had become impressed with the future of these mines, renewed the effort to have them opened. His own capital was inadequate to carrying forward so large an enterprise, and he succeeded in interesting the late Charlemange Tower, of Philadelphia, and some other gentlemen, in the hills of the Masaba. Although some surveys were made and some other little preliminary exploration was carried on, nothing more was done for some years. In 1881, an expert visited the mines in the interest of Mr. Tower, and, his report being favorable, in the following year the work of locating the Duluth & Iron Range road, from Vermilion Lake to Agate Bay, now known as Two Harbors, was begun. The route selected was one that required extraordinary engineering skill, an abounding faith in the richness and extent of the deposit, and the outlay of millions of dollars. It has been estimated that to carry out the explorations and surveys, build and equip the road, develop the mines, and provide dock facilities must have required the expenditure of at least three millions, before the property was in shape to pay a single dollar. Since that time, both road and mines have been some of the most productive properties in the United States. In 1885, the work of extending the road down the lake shore to Duluth, a distance of twenty-eight miles, was begun, and was completed in 1886. In 1888 the line was extended twenty one miles east of Tower, to Ely, and it will soon be pushed on to the Canadian line, to meet the Port Arthur, Duluth & Western road, which is already oper-

ating to that point. This will give a connection with the Canadian Pacific at Port Arthur, and thus the entire Vermilion country will be opened up. The Duluth & Iron Range necessarily crosses the Masaba range to reach Vermilion, and from the Masaba station is building a branch westward to the town of Merritt, on the shores of Embarass Lake. Here it will connect with the other roads that are making for the heart of the Masaba mining country, and thus belt a large portion of the range. It also contemplates running its own lines farther west as the developments proceed, and will in all probability put in an eastern mineral branch, as soon as the country toward the Pigeon River Reservation has been a little more thoroughly explored.

The Duluth, Missabe & Northern is rapidly building into the Masaba region from Stony Brook, on the Duluth & Winnipeg road, thirty-nine miles east of the city, and will eventually complete its own line to the docks on Duluth's magnificent water front. This line will connect with the extension of the Duluth & Iron Range road at Merritt. The route selected by the projectors of this road is the natural one into the Masaba country. The St. Louis river heads in the range, and is the confluent of the chain of lakes that drops from the crest of the watershed at the "hights of land." It is up this line of drainage that the road is being built, and as it follows the tributaries of the St. Louis most of the way, the grade is easy, the cost of construction comparatively light, and the actual distance to Duluth from the central portions of the range, about sixteen miles less than by the Duluth & Iron Range road. This road is to be extended beyond the present seat of mining, and into one of the finest agricultural regions in Minnesota. It embraces the Leech Lake Indian Reservation, and has an area about equal to the state of Connecticut, so that in addition to the profitable business that it will do in ore transportation, it will eventually have a large token of traffic in agricultural products, after having carried away the vast lumber cut, which on a low estimate is not less than 2,000,000,000 feet. The work of construction is progressing rapidly, and the company has just contracted with the West Duluth Car company for the construction of four hundred cars, a portion of its equipment, which will be ready when the ore traffic opens, in about three months.

Near the head waters of the Mississippi, the Duluth & Winnipeg railroad is building a branch from its main line directly to the center of the range, and will afford ample shipping facilities for those who have located mines in that direction. Some of the properties here found have shown remarkably good assays for manganese, and some of these ores will undoubtedly be worked for that valuable product, rather than the iron. The existence of large and valuable ore deposits in this portion of the range was pointed out by Prof. H. V. Winchell in the geological report of 1889, after he had devoted a season to research in the region of Grand Rapids, and the accuracy of his predictions has already been in part realized. Doubtless as the road is completed, and better facilities for exploration are afforded, it may be found that the mineral wealth throughout this section of the range is fully equal to that which has been so successfully devel-

oped in the central portion. As will be seen by the accompanying railroad map, the Duluth & Winnipeg, while tapping a different portion of the range, must eventually connect its spur with the other roads, and as this is also true of the Red Lake Falls & Northern, transportation facilities to Duluth will be afforded by several routes to nearly every mining center on the range.

The Red Lake Falls & Northern road has been granted a right-of-way to Park Point, where it will erect docks on the bay, and will be built as primarily an ore road, though it, too, will open up a fine lumber and agricultural country, as well as affording an additional outlet for the mines. The surveys which have already been made locate the line directly up the Lester River, in the eastern suburbs of the city, and thence sixty miles northwest into the Masaba iron country. It is the intention of the projectors to ultimately push the line directly northwest across the Masaba, Giant and Vermilion ranges, through the reservations, and on toward Northern Dakota as soon as those portions of the State are opened up. It will eventually have a large cut of timber to remove in addition to its ore, and later on its passenger traffic.

It is more than probable that the St. Paul & Duluth railroad will extend its Cloquet branch east, and also tap the range at some convenient point, and thus secure for itself a share of the enormous mineral traffic that will be developed within the next few years. The history of mineral branches and feeders throughout the country has been such as to make almost any railroad feel assured of a good profit on such construction. The Duluth & Iron Range has been a veritable bonanza; while the system of feeders put in by the Louisville & Nashville railroad in the Birmingham, Ala., district have all proved some of the most productive portions of the roads which constructed them, and now do a good passenger business in addition to the ore traffic.

There will be no lack of railroad facilities at any of the mines that are being opened upon the Masaba range. There is hardly a property that has been located, which is not within so short a distance from one of the proposed lines that it can have its own switch put in at little cost, while most of them are contiguous to several, and are thus assured of the advantages in cheap transportation that accrue where there is active competition.

Thus far the transportational facilities that have been considered have only been those which are to bring the ore from the mines to Duluth. While it is true that a constantly increasing portion of it will be used here, by far the largest part is destined to go east and south to the present iron manufacturing centers, and by far the largest part of its journey will be by the great chain of lakes. It is not necessary to dilate on the cheapness of such transportation nor the manifest advantage that accrues to Duluth by reason of her position at the head of lake navigation, with a tranquil natural harbor in which the merchant marine of the world might ride at anchor uncrowded. All sorts of lake craft will take cargoes of Masaba range ore to Cleveland and Buffalo on its way to the furnaces at a rate that could be obtained by no other means of transportation, so that as a distributing

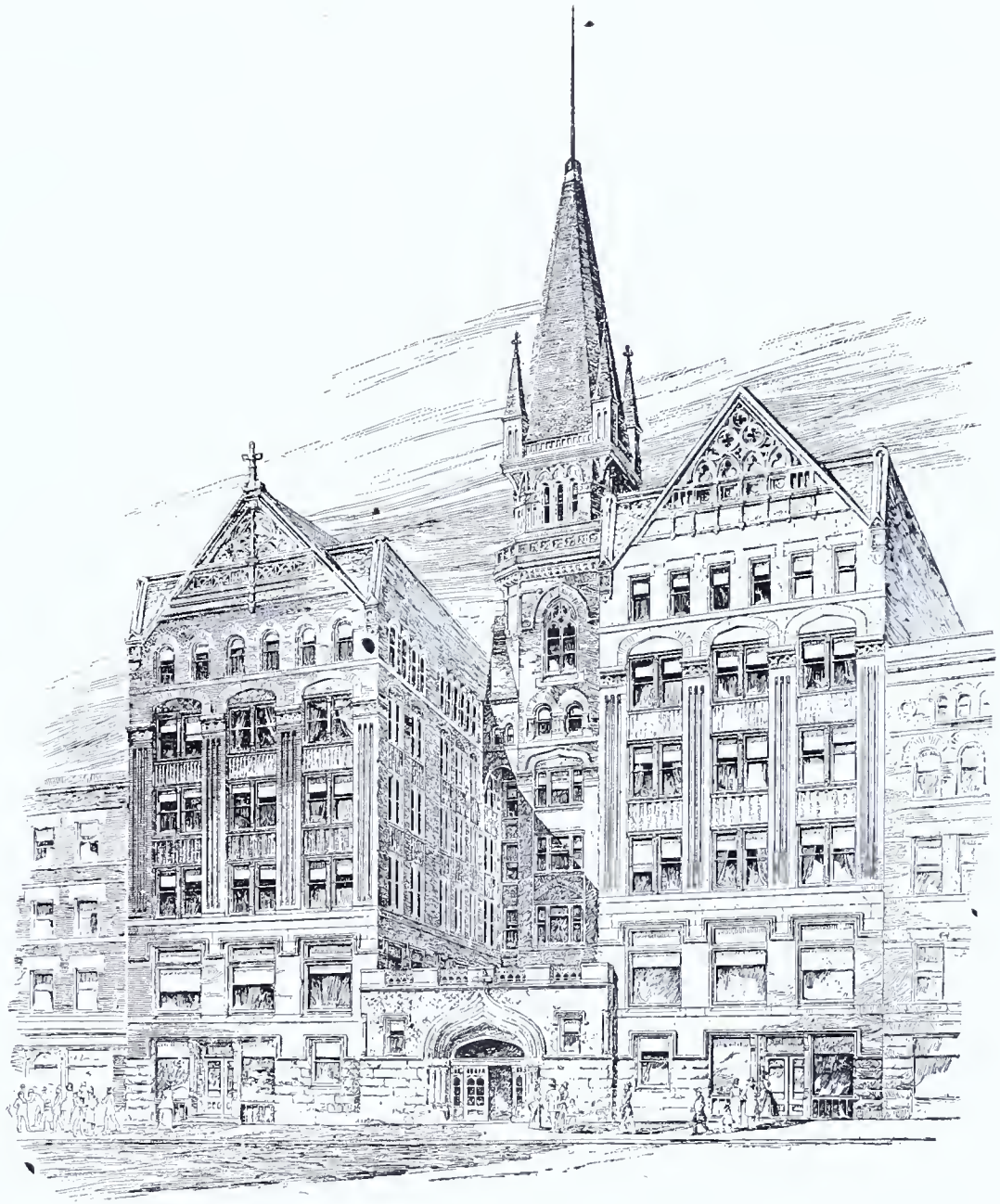
point, the city is unexcelled. All this is recognized. Within the past few years, however, there has come upon the lakes a new type of vessel that is destined to work wonders in the way of cheapening transportation, and which may in time result in delivery of Minnesota ores to the iron masters of Birmingham, England, at prices that will make it worth their while to use the mineral of Masaba. The vessel referred to is, of course, the McDougall "whaleback" steamer, and an account of these vessels is quite appropriate at this point.

As is probably known to most readers of this pamphlet, this new type of vessel, which seems destined to eventually revolutionize the lake and perhaps the ocean carrying trade, is the invention of Capt. Alexander McDougall, and is the result of a long experience on the lake merchant marine. It was a question when the first of these peculiar looking craft was launched, whether or not "it would float." The first test demonstrated not only that it would float, but that it would carry a large cargo with ease and safety, and the small crowd of curious spectators who witnessed the launching at once discerned the far-reaching importance of the invention and saw in the vessel that was so devoid of any of the beauty lines of construction, as beauty has been outlined for the past hundred years, the forerunner of a race of craft that in a few years is destined to be seen in the waters of every portion of the globe.

The patents on this singular type of boat passed into the hands of the American Steel Barge Company in 1890, and a practically unlimited amount of capital was secured by interesting such men as the Rockafellers, Hoyts, Colbys, and others of New York, Thomas Wilson, of Cleveland, A. D. Thompson and the inventor, who became the principal stockholders of the concern. The company has large shipyards at Superior, opposite Duluth, and at Everett on Puget Sound, and from these a large number of vessels have been launched and put into commission during the past two years.

The steamer Charles W. Wetmore is the vessel of this type that is best known, and has probably created more talk in marine circles than anything that has been built since Ericsson's famous monitors were launched thirty years ago. This vessel is a purely utilitarian type, was designed strictly for business, and dissipates all the romance of maritime exhibition, and carries much more grain than poetry. It is 265 feet long, 38 feet wide and 24 feet deep. Under water the boat is much the shape of any other vessel, except that the bow is rounded up like the end of a cigar, and ends in a curious flattened point, that is not unlike the snout of a pig. Above water the sides simply arch over until they meet, so that a section of the ship above the water line is simply half an elipse. Forward there is a small turret, and two more and a smoke stack are located in the stern. On top of these two latter, supported by pillars, are the wheel house, quarters for the officers, chart room and other executive portions of the vessel. Save a light wire railing, which extends from turret to turret fore and aft, the upper portion of the boat, which is not more than four feet out of water when she is loaded, presents no obstacle to the waves, which in a gale can go rolling

MASONIC TEMPLE.



CHAMBER OF COMMERCE.

across her, scarcely impeded by her pressure. This peculiarity of her construction makes the Wetmore and other boats of the type much less liable to roll in a heavy sea than those that have heavy spars, rigging and top hamper. The waves are as impotent to get any hold on her as are they with a duck's back, and they roll off her convex surface in much the same way.

Except at the forecastle and the engine room, which is below, aft, the entire vessel is a vast hold, divided by water-tight compartments, and closed with steel, rubber-lined hatches, which are water proof. Equipped with powerful engines, and pumps to handle her water ballast, when light, she represents the most compact and economical form of steamer ever yet produced. The whaleback barges, of which she can tow two, are constructed in the same form but have no machinery, and only one turret forward, which serves as the quarters of the five men who man the barge. The three boats will thus carry about sixty thousand gross tons, making ten knots an hour on a consumption of twelve tons of coal a day.

The first great achievement of the Wetmore was to astound the world by chartering with wheat from the head of the lakes to Liverpool. The vessel was lightered of her cargo at Kingston on Lake Ontario, ran the rapids of the St. Lawrence with a pilot, reloaded at Montreal, and with 226 tons of coal on its turtle-back, made its way to Liverpool without having a pound of the coal disturbed or the footprints in the top of its cargo filled in. After creating sufficient marvel among the ancient mariners of England, it left Liverpool in water-ballast for New York, where it arrived in eleven days. In thirty days more it had been reloaded with machinery and coal, and left Wilmington, Delaware, for a voyage of 15,000 miles to Puget Sound, where it arrived in seventy days, and where it is now in the San Francisco coal business. The accomplishment of these trips was not so much in running the rapids of the St. Lawrence, but in the demonstration of the practical fact that here in the heart of North America could and would be built steel steamers that would materially lessen the carrying charges between the Great West and Europe, if only a free waterway to the ocean were provided.

It is this new method of lake transportation that is destined to give the cheap ores of the Masaba range a special advantage over those of almost any other locality in transportation to the eastern points. "I would not be at all surprised," said Capt. McDougall to the writer, "to see the freight rate on ore from Duluth to Cleveland, Buffalo and other lake ports, reduced from one dollar to seventy-five cents, as soon as the Masaba mines go into production. We can carry it in the whalebacks for that price and make a handsome profit, and it will probably be done."

There is another feature about this method of cheap transportation. It is that the vessels will not have to return light, but can bring back coking coal at a proportionately cheap rate. This matter will be referred to hereafter.

The new passenger whaleback that the company is building for the World's Fair, and that will run between Jackson Park and the mouth of Chicago river, will run as a day boat only. The boat will be 362 feet long, and carry four thousand passengers. She is of a construction similar to the freight propellers, and though novel, is quite graceful in outline.

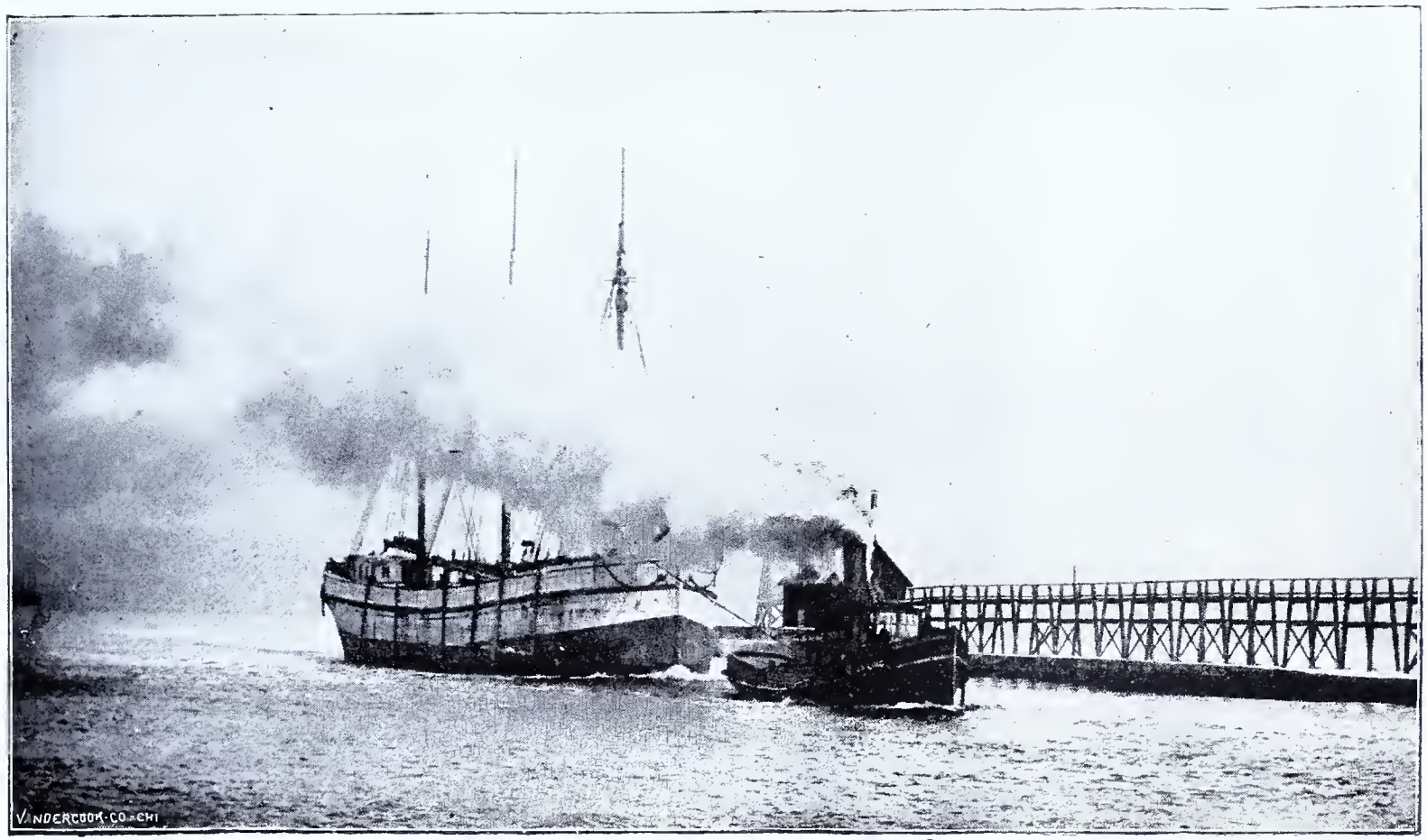
# Concerning Magnetic Separation.

HERETOFORE this comparatively new process of the treatment of iron ores has not been put into practice on the Masaba range; and indeed it is still a matter of experiment among the iron ore men of the East, who are busy with the various forms of electrical concentrators that have been patented during the last two years. Edison, the wizard of Menlo Park, has been devoting his seemingly inexhaustable inventive genius to the subject, for more than two years, and has leased large tracts at Ogden, N. J., where he is experimenting with lean magnatites with a considerable degree of success. The vein at that point contains from forty to forty-five per cent of iron, and is quite narrow, and would not be available as an iron supply under any other process. From the arrangements of his plant, however, he is able to handle from 1,000 to 1,200 tons of the ore bearing rock per day, and produce a high grade concentrate which has a ready market among the more progressive of the iron masters. The same thing is being done at the Croton mines, near Brewster, N. Y., where a breast is being worked for the concentrators even under more favorable conditions than those which exist at Ogden. At Tillie Foster mines, in Putnam county, New York, and at various other points, separating machines designed by different inventors are being given the most thorough tests, and the results in each case point to the ultimate successful reduction of all lean magnatites, and possibly some grades of lean hematite which become magnetic by roasting, to a merchantable product by this process. There are at present two methods in vogue, which are most minutely described by Mr. Alex. Sahlin, in a series of thoughtful articles which have been a feature of the Engineering and Mining Journal for the past three weeks. It does not lie within the province of this article to discuss at length the special advantages which attach to each one of the various processes which have been devised to secure concentration. Suffice it that the process is one that is destined to play a very important part in the preparation of ores for the furnace, as is attested by the fact that many of the most prominent furnacemen, who are accepted as authority, are using from thirty-five to sixty per cent of concentrators.

Mr. John Fritz, of Bethlehem, Pa., who is conceded to be one of the best iron masters of the East, and a standard authority, has used as high as eighty per cent of concentrates in his furnace without making the burden so close-packed as to interfere with the blast or increase the pressure materially. Other prominent furnacemen agree with him, and except among the ultra conservative metallurgists concentrates have today but few antagonists among the American iron masters. The Lackawanna Iron and Steel Company, of Scranton, Pa., which gave the concentrates the first trial, with a 200-ton lot, in 1884, was, five years afterward, the highest consumer, using 80,000 tons in 1888, and a proportionate increase since that time. Other furnaces have similar records of large consumption, and at the Port Henry furnaces, Mr. N. M. Langdon has used as high

as eight-tenths of all the ore charged in the form of concentrates.

One of the great advantages claimed for the ores in the form of concentrates is the ease and cheapness with which they may be handled. The concentrator delivers them by a system of elevators into a series of pockets, from which they may be loaded on the cars or vessels like so much grain, and without intermediary work, and the same process may be resorted to both in unloading and in their delivery to the charging floor, when they arrive at the furnace. Those which are produced by the wet process, dry rapidly, and there are devices used in connection with such machines which accomplish this step in the operation of treatment artificially, and at little cost, delivering the ore in the form of a coarse pulverant of about the granulation of ordinary grain. This, and many other features of the process, make it one that is attracting much attention among the iron men today.




ENTERING DULUTH HARBOR.

# Iron and Steel Production at Duluth.

UNIFORM progress westward of the center of iron and steel production for the past two decades has demonstrated practically the prophesy of Andrew Carnegie, when he said that the headquarters of the industry would keep pace with the movement of the center of population until it reached the point nearest the most abundant supply of Bessemer ores, provided such locality was a convenient distributing center, and had facilities for cheap transportation to the consuming centers. During the first decade Chicago suddenly loomed up as a heavy Bessemer iron producer, and met the Pittsburg people on their own ground at competitive rates, underbidding them in the markets of the middle western states. Now a similar movement is carrying the headquarters of the industry five hundred miles north and west of that point, and much nearer to the source of the best Bessemer ores. Prior to the discovery of the vast amounts of ore on the Masaba range, this change of the probable base of operations was brought about merely by the fact that the Lake Superior region was furnishing about ninety per cent of all of the steel ores used, and the fact was abundantly demonstrated that it was cheaper to take the fuel to the ore than to carry the ore to the fuel, where the lakes could be made available for a large proproportion of the transportation. Less than a year ago it was stated on good authority that within the next two decades it was reasonably probable that the head of the lakes would become the center of the steel production, and progress in this direction has been so marked as to place the ultimate result beyond peradventure. The history of the pioneer concerns that have taken advantage of the situation is such as to assure success, and the figures in which are written the records of the first experiment prove conclusively the tenability of all the prophecies as to steel fabrication that have thus far been made. The concerns that are now at work at such a good profit, even when iron and steel are so depressed, are but the precursors of dozens of similar plants that will be located in obedience to the best laws of economic production to reap the rich harvest that will be afforded by the special advantages of cheap ore, coke, and transportation, and the special advantages that Duluth possesses as a distributing center. The volume of trade which is the direct result of development and constructive work lies toward the north and west. Fabricated products here find their natural market; and, obedient to immutable laws, define the periphery which circumscribes the natural center of manufacturing for not only the cruder forms of the metal, but all of its allied industries. The story of the other iron ranges of the northwest points to the future of the Masaba and its tributary country with unerring accuracy.

The Marquette, which occupies the most prominent place on the northern peninsula of Michigan, has, for thirty-five years, been producing a high grade of Bessemer ore. In that period its mines have had an output of 35,234,543 tons of ore, or at the rate of over a million of tons of iron per annum. The Menomi-

ENDION SCHOOL

nee, during its thirteen years of production has put out 14,493,436 tons, or about 1,100,000 tons per year. The Gogebic, which was not actively worked until 1885, has, in seven years, produced 10,281,923 tons, and has not yet had its available productiveness perceptibly lessened. Used in the proportion of one to two with the ores of the Vermilion, it commands the highest place among the steel workers, and shares laurels only with the ores of the latter range which are "the purest and best ores mined to any extent in the world." In the seven years that these mines have been in operation they have produced about 4,117,186 tons, and, as an inspection of the ore prices for that period will establish, have commanded the best figures in the market.

The judicious admixture of the various grades of ore is one of the secrets of the successful furnacemen, and he must have access to each kind on his stock pile to meet the various conditions of his furnace, and the grade of iron that he desires to produce and has a ready market for. If one were to take a pair of compasses and draw a series of concentric circles that would touch all of these great deposits he would find that they were all about equidistant from Duluth, except the Masaba, which is, as has been shown, the most economically mined of any of them, while it is even nearer at hand. A shade under one dollar a ton has been the estimated cost of iron ore from the Masaba range laid down at Duluth. Using the figures of an eminent member of the Iron Workers' Association, the estimated cost of making iron at three lake ports is as follows, and is taken from the report of the statistician at the head of the lakes:

| | Duluth. | Cleveland. | Chicago. |
|---|---|---|---|
| One ton Vermilion ore | $ 4 50 | $ 4 50 | $ 4 50 |
| Freight | ..... | 2 09 | 1 30 |
| Dock charges or transfer | 20 | 30 | 30 |
| One-half ton Gogebic ore | 2 08 | 2 08 | 2 08 |
| Freight | 26 | 1 04 | 78 |
| Dock charges or transfer | 10 | 15 | 15 |
| One ton coke at furnace | 5 50 | 3 50 | 5 50 |
| Total | $12 64 | $13 51 | $13 61 |
| Deduct saving Masaba | 1 20 | ..... | ..... |
| Balance | $11 44 | $13 51 | $14 61 |

It will be noted that in this estimate that for the sake of being conservative the price of delivered Masaba ore has been considerably weighted. It will not in all probability reach anything near the figure given with the cheap mining methods that are to be employed. Such careful figuring suggests a convincing corollary that no thoughful business man can miss.

## A Word About Coke.

For the past two years the experiment of making coke at lake points like Duluth has been tried with a great deal of success, and though no plant has yet been erected in the city limits, the results achieved on the other side of the bay, from which point comes a full fuel supply for the West Duluth blast furnace, now in such successful operation, has demonstrated that with the cheap lake freights, and a very rich ore within a few miles, comparatively speaking, coke from a new industry will smelt the rich

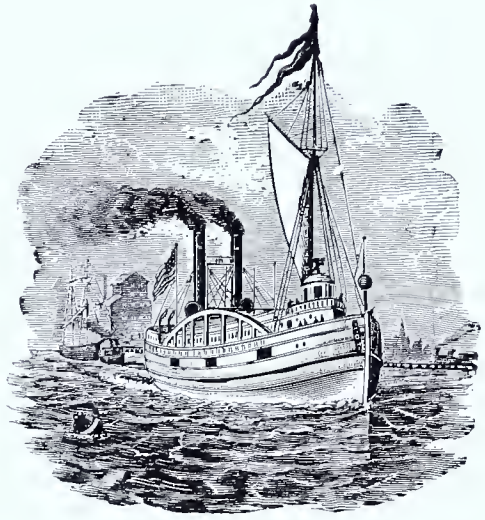
Masaba ores. The contracts for the past year have been about $5.25 per ton, and the best form of furnaces has not been in use to convert the crude fuel. Simple bee-hive ovens are used, and all of the by-products, which under the German system nearly pay for the conversion, are wasted. In the near future an improved plant will probably be erected in the city, and from it will be derived fuel, which, when the richness and purity of the ores of the Masaba range is taken into consideration, will make iron of a Bessemer grade superior to any other that can be found in the country. Figures from a very conservative iron man, who is now deeply interested in the project, place the estimated cost of manufacture by the simple methods now employed at the following figures:

| | |
|---|---|
| Cost of the best Connellsville coal at mine, | $1.00 |
| Freight from Connellsville to lake ports, | 1.00 |
| Loading, | .20 |
| Lake freight to Duluth, | .30 |
| Unloading, | .20 |
| | $2.70 |

One and a half-tons of coal will make a ton of good coke, and this allowing a waste of five per cent., and fifty cents for the coking, would make the figures $4.75, which may be further weighted with fifty cents to cover interest, repairs and delivery—a total of $5.25 for the fuel at the furnace. The Structural Steel Company, of Superior, one of the most successful concerns in the Northwest, which produces all of the plates from which the famous McDougall "whaleback" boats are constructed, has taken the entire output of the West Duluth blast furnace, a matter of 125 tons a day, at a profit of over $2.00 a ton above the Pittsburg price, to the manufacturer; making steel of it and reserving a handsome profit for itself. It will therefore be seen that this point will become the center of iron and steel manufacture for western consumption, since the furnace men will get their ore $1.40 cheaper than those at Chicago can secure the same grade at, and have an advantage of $3.50 per ton on pig iron, even if coke should be a dollar cheaper a ton there. Not only will the iron be manufactured for the purposes of steel fabrication, but a lower grade will keep busy many establishments utilizing this great servitor of civilization in its crude form; and the profits which will thus accrue can only add to the volume of the city's prosperity. A thoughtful article on this subject puts the proposition tersely as follows:

"The profits on mining the ore and coking the coal would remain here, but beginning with $10.50 as the cost at the furnace of the materials for the manufacture of a ton of pig, practically all additional expense is for labor. There is a loss of ten or twelve per cent in transforming the pig to the finished product, but if the cost of material is put at $12, labor will do the rest, and a single ton of iron made into stoves, brackets, ornamental articles and the innumerable forms in which it is now found useful, will sell at many fold its original cost, and all this advance is in labor and profit that will go to build up Duluth. If $12 worth of material can, by the magic touch of labor, be sold at $50, Duluth is $38 the better off, and a million tons so transformed is no small

consideration to our city. The iron ore ought not properly to be figured as an expense, as its cost at our furnace doors is all included in labor and profits that remain here, and thus the coal alone is a drain upon our resources. The manufacture of iron at this point is therefore not only practicable, but highly profitable, and only by establishing institutions for this purpose here can Duluth retain a tithe of the advantage which nature has bequeathed to her. To ship ore at $3 a ton that can be given ten fold that value by labor here, and the difference retained for the growth and glory of Duluth would be a peerless folly. There are millions in iron manufacture at the head of Lake Superior, and Duluth will not permit them all to get away."



# As to Lake Transportation.

CONSIDERABLE mention has been made in the preceeding sections of this book as to the relative cheapness of lake transportation, over any other form now in vogue, and the peculiar advantages that accrue to Duluth as a manufacturing point by reason of her position at the head of lake navigation. It may not be amiss, therefore, to reproduce some statistics which received sanction of accuracy from the Deep Waterways Convention, last year.

Without waiting to discuss the problem that is presented by the development of transportational methods, and to decide whether or not the present high degree of civilization was evolved from the improved methods, or that the methods themselves are the product of the civilization, and an increment of its progress, an excerpt from one of the ablest addresses delivered at Detroit will fully answer the question of what is now the course of the main arteries of commerce. In this address it is pointed out that while, for the past decade and a half there has been continually increased efficiency and decreasing cost in railway transportation, owing to the reduction of grades, lessening of curves, the construction of more powerful locomotives, and the building of cars of so much greater paying freight-carrying capacity, the deduction of dead weight in proportion to the dynamic energy expended has been enormous, the fact has been accentuated that the progress and improvement in the construction of steam vessels has kept pace with the rail improvements.

In Poor's Railroad Manual the average rate per ton for all of the railroads in the United States, which, in 1882, was 1.236 cents per mile, had been reduced in 1890 to .941 cents, or 24 per cent in nine years.

The Chicago Board of Trade, in 1885, issued a table showing the average cost of carrying a bushel of wheat from that city to New York by the three methods in vogue for the eighteen years previous, and since that time there has been little if any change in the figures. The table is as follows:

| Calendar Years. | Lake and Canal.* | Lake and Rail. | All Rail |
|---|---|---|---|
| 1868 | 25.3 | 29.0 | 42.6 |
| 1869 | 24.1 | 25.0 | 35.1 |
| 1870 | 17.5 | 22.0 | 33.3 |
| 1871 | 21.6 | 25.0 | 31.0 |
| 1872 | 26.6 | 28.0 | 33.5 |
| 1873 | 19.2 | 26.9 | 33.2 |
| 1874 | 14.2 | 16.9 | 28.7 |
| 1875 | 11.4 | 14.6 | 24.1 |
| 1876 | 9.7 | 11.8 | 16.5 |
| 1877 | 7.5 | 15.8 | 20.3 |
| 1878 | 10.1 | 11.4 | 17.7 |
| 1879 | 13.0 | 13.3 | 17.3 |
| 1880 | 13.2 | 15.7 | 19.7 |
| 1881 | 8.6 | 10.4 | 14.4 |
| 1882 | 8.7 | 10.9 | 14.6 |
| 1883 | 8.40 | 11.5 | 16.5 |
| 1884 | 6.59 | 9.9 | 13.2 |
| 1885 | 4.55 | 9.06 | 14.0 |

*Including Buffalo charges and tolls.

The increment of reduction is manifestly in favor of the lake transportation; but there are still stronger figures to consider.

The 9,014,213 tons of freight which passed through St. Mary's Falls canal in 1890 was carried an average distance of 796.2 miles, at an average price of only 1.3 mills per ton, or 1-7 of the price received by the railroads during the same period. Wheat has been carried from Chicago to Buffalo for .04 per ton per mile frequently. Duluth, on account of the enormous return freightage in grain, has had coal laid down as low as 10 cents a ton from Buffalo, or .01 per ton per mile.

Maritime reports show that the average freighters plying between Duluth and Buffalo carry about 2,705 tons of freight, and make the run in about three and one-half days, at a cost of about $120 per day. Assuming that the distance is 1,000 miles, that means .015 cents per ton per mile, or only 1-26 the cost of movtng the commodities on the Lake Shore road, which has made the most favorable report in the way of cheap net hauling for some years. The figures thus far considered are based upon absolutely existing conditions, and the present depth of water in the "Soo" canal. With the improvements contemplated by the government, and the possibility of constructing vessels of greater draught, with twin screws, the ratio between cost and carrying capacity would be even less than this. To the business man who sees by these figures that it costs $26 on the most favorably situated railroad in the country to do what can be done on the lakes for $1, comment is unnecessary, and the claims made for the benefit that is to accrue to Duluth by the interchange of her surplus ores for needed cokes and coals will not seem exaggerated.

# A Word at Closing.

IT IS NOT possible in summing up the advantages of Duluth and the Masaba mines to crystalize into a few paragraphs all of the facts that have been noted; but it may not be amiss to recall some of them, in a much condensed form.

Geographically they are situated at a point most central to the areas of steel consumption during the next few decades. The construction of new roads, the erection of new towns and the accretion of new centers of population, which will mark the immediate development of the Great Northwest, proves it.

Geologically they are located in a terrane that has already been proved to be one of the most productive known, and where the contours are such that the most economic and profitable methods of mining can be resorted to for years to come.

Genetically they were produced at a period when kindly nature was in her most generous mood, and under conditions of her then active laboratory that insured them a richness unsurpassed by any ore mined to any extent in the world.

Abundant and cheap transportational facilities bring them to a peerless place for reduction or shipment, where a fuel supply can be obtained at a nominal price, when the other facilities for fabrication are taken into consideration, and the enterprise and energy of a progressive city bids all welcome who desire to join her in the glory of their development.

# APPENDIX.

Detailed information concerning a number of companies whose stocks are at present most active on the Board of the Stock Exchange is shown in the following tables, which were prepared by the Secretary, Col. J. B. Geggie, from the reports made, and the statistics were arranged by him for the use of the members of the exchange. The tables show at a glance what could otherwise be found only by considerable research, and is a comprehensive statement of the present status of developments. The tables are on the following pages:

| Company. | Officers. | Capital. | No. Shares. | Par Value. | Amt. Working Capital. (Shares.) | Authorized Indebtedness. | Is Stock Assess. | Fee Lands. Acres. | Leased Lands. Acres. | Royalty—Per ton. | Min. Output per Annum, Tons. | Quality of Ore. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biwabic Mountain Iron Co | Leonidas Merritt, President.<br>E. H. Hall, Secretary.<br>E H. Hall, Treasurer. | $3,000,000 | 30,000 | $100 | 18,000 | ..... | No. | 120 | 1,960 | Part 25c<br>Part 30c | 1,000 tons within 5 years; 5,000 annually afterwards. | Bessemer ..... |
| Cincinnati Iron Co | A. E. Humphreys, President.<br>Frank Cox. Secretary.<br>M. O. Brooks, Treasurer. | 3,000,000 | 120,000 | 25 | 20,000 | ..... | No. | ..... | 320 | Part 25c<br>Part 30c | 10,000 | Bessemer..... |
| Cosmopolitan Iron Co | Wm. McKinley, President.<br>H. P. Taylor, Secretary.<br>John McKinley, Treasurer. | 4,000,000 | 40,000 | 100 | 5,000 | ... .... | No. | ..... | 920 | 30c | 73,333 | |
| Clark Iron Co.. .. ..... ..... | M. J. Clark, President.<br>M. W. Bates, Secretary.<br>J. G. Williams, Treasurer. | 3,000,000 | 30,000 | 100 | 10,000 | .. .... | No | 280 | ... ..... | ..... ... .. | ..... ..... | ..... ..... |
| Great Northern Iron Co..... | Alfred Merritt, President.<br>G. L. Robbins, Secretary.<br>E. T. Merritt, Treasurer. | 3,500,000 | 35,000 | 100 | 23,000 | $50,000 | No. | 2,100 | ..... | ..... | ..... ..... | Bessemer..... |
| Keystone Iron Co... ..... .. | C. Markell, President.<br>E. R. Brace, Secretary<br>H. W. Pearson, Treasurer. | 3,000,000 | 30,000 | 100 | 14,000 | $100,000 | No. | ..... ..... | 720 | 25c | 1st yr 22,500 tons, 2d 45,000; 90,000 tons per ann. thereafter | ..... |
| Kanawha Iron Co..... | A. E. Humphreys, President.<br>Frank Cox, Secretary.<br>Frank Cox, Treasurer. | 2,000,000 | 20,000 | 100 | 2,500 | ..... . | No. | ..... .. | 160 | 30c | 35,000 | Red Hematite. |
| Lake Superior Iron Co ..... .. .. | W. F. Mattes, President.<br>A. J. Trimble, Secretary<br>P. Deyo, Treasurer. | 5,000,000 | 200,000 | 25 | 20,000 | ..... | No | ..... | 4,520 | Part 25c<br>Part 30c | After one year, 100,000 tons per annum. | Bessemer ..... |
| Little Mesaba Iron Co. ..... ... | R. W. Cavenaugh, President.<br>E. F. Dodge, Secretary.<br>E. F. Dodge, Treasurer. | 3,000,000 | 30,000 | 100 | 10,000 | ..... | No. | ..... | 960 | 25c | 1st yr 15,000 tons, 2d 30,000; 60,000 tons per ann. thereafter | Red Hematite. |
| Lincoln Iron Co..... ... | John McKinley, President<br>S. W. Eckman, Secretary.<br>G. J. Atkins, Treasurer. | 3,000,000 | 30,000 | 100 | 5,000 | ..... | No. | ..... .. .. | 760 | 30c | 50,000 | Bessemer..... |
| Mountain Iron Co..... | Leonidas Merritt, President.<br>S. R. Payne, Secretary.<br>Alfred Merritt, Treasurer. | 2,000,000 | 20,000 | 100 | 8,000 | .. ... | No. | 980 | 1,920 | 25c | 1,000 tons within 5 years; 5,000 annually afterwards. | Bessemer..... |
| Minneapolis Iron Co..... .. | John McKinley, President.<br>E. M. Mabie, Secretary.<br>A. R. McGill, Treasurer. | 3,000,000 | 30,000 | 100 | 5,000 | ..... | No. | ..... | 600 | 30c | 80,000 | Hematite..... |
| Mesaba Mountain Iron Co.... .... | Leonidas Merritt, President.<br>L. J. Merritt, Secretary.<br>L. J Merritt, Treasurer. | 3,000,000 | 30,000 | 100 | 20,000 | ..... | No. | 240 | 1,800 | 25c | None for 5 years. | Bessemer..... |
| Shaw Iron Co..... | Alfred Merritt, President.<br>A. J. Tallon, Secretary.<br>A. R. Merritt, Treasurer. | 3,000,000 | 30,000 | 100 | 14,000 | ... .. | No. | 1,000 | ..... | ..... .... | ..... ..... . | Soft Hematite. |
| Security L. & E. Co.. ... ..... | J. T. Hale, President,<br>Jesse Norton, Secretary.<br>G. W. Buck, Treasurer | 100,000 | 10,000 | 10 | 1,200 | ..... | No | 3,500 | ..... | ..... | ..... . ..... | Not an Iron Co. |
| Washington Iron Co..... | T. B. Mills, President.<br>M. W. Bates, Secretary.<br>W. B. Welles, Treasurer. | 3,000,000 | 30,000 | 100 | 10,000 | $100,000 | No. | 880 Contract f'r purch'e | 80 State option. | 6¼c | None | Bessemer . ... |

## LOCATION OF PROPERTIES.

In Townships 58-16, 58-17, 58-18, 58-19, 59-14, 65-5, 63-10, 63-12, 61-14, 62-14, 60-12, 62-15 and 64-4—124 acres leased to P. S. Kimberley: Royalty 50 cents. Minimum output, 300,000 tons per annum. 43 acres leased to Jno. Barringer; Royalty 50c; Min. output 100,000 per annum.

In Section 2, Township 58 N., Range 16 W. Sub-leased to H. S. Barber at 55 cents per ton royalty. Minimum tonnage per year, 150,000 tons.

In Sections 5, 7, 8, 9 and 17, Township 58 N., Range 18 W., and in Section 34, 59 N., Range 18 W.

In Sections 23, 28, 32 and 33, Township 58 N., Range 20 W.

In Township 58 N., Ranges 17, 18 and 19 W., and in Township 59 N., Range 18 W.

In Sections 10, 11, 13, 15, 20 and 21, all in Township 58, N., Range 18 W.

In Section 1, Township 58 N., Range 16 W. Royalty begins when railroad is built within one mile of property.

In Township 57 N., Range 21 W., and in Township 58 N., Range 20 W.

In Section 12, Township 57 N., Range 22 W., in Secs. 17 and 20 Township 59 N., Range 14 W., and in Secs. 22, 27 and 28, Township 59 N., Range 15 W.

In Sections 4, 5, 6, 7, 8 and 17, Township 58 N., Range 17 W. First payment royalty due January 1, 1893.

Fee lands in Sections 31 and 34, Township 59 N., Range 17 W., Sections 32 and 34 Township 59 N., Range 18 W., and Sections 3, 4 and 6, Township 58 N., Range 18 W. Leased lands—all Section 16, 58-18, all Section 36 58-21, and all Section 16, 58-19, in St Louis county.

In Sections 19, 29, 30 and 32, Township 58 N., Range 17 W. Royalty to commence one year after railroad is built into Township 58-18, or 57-17 or 58-17.

In Townships 57-21, 58-17, 58-18, 58-19 and 58-20, in St. Louis county.

In Township 58 N., Range 16 W.

In Townships 54-16, 58-20, 57-20, 58-15, 58-17, 57-17 and 58-16. Leased to Towanda Iron Co. 400 acres; leased to Youngstown Iron Co. 1,000 acres; leased to New York Iron Co. 1,200 acres; leased to Security Iron Co. 840 acres; option given for 80 acres; 30 cents per ton royalty for each. Min. output per annum, 30,000 tons each.

Fee lands in Township 58 N., Range 20 W. Leased lands located in Township 58 N., Range 21 W.